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ABSTRACT

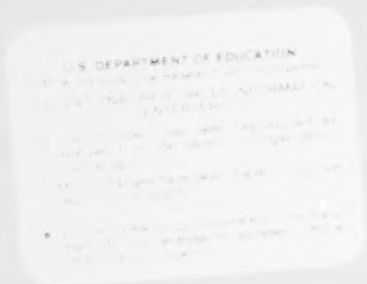
This document presents an environmental education curriculum and associated materials for the middle school. The organization of the document is intended to be simple and understandable. Because the curriculum described here is organized around a set of commonly accepted goals for curriculum development in the field, Chapter I focuses on those goals and their validity, and an effort is made to put these goals into perspective for the curriculum developer. Chapter II focuses on environmental education and the middle school learner. Very specific suggestions are made with respect to the methods that can best make a middle school curriculum work for learners. Methods associated with the use of the case study in environmental education, issue investigation, and citizenship action training are included. Other strategies deal with topics such as the use of community resources, the effective use of field trips, role playing, simulations, and panel discussions. Chapter III presents the prototype curriculum itself in outline form. The 3-year curriculum is divided into three components: (1) ecological foundations; (2) environmental science and environmental health; and (3) issue investigation and citizenship action training. Chapter IV discusses the infusion of environmental content and skills into existing courses at the middle school level. Examples of infusion and team-teaching approaches are presented along with a detailed outline which offers suggestions for infusing Chapter III's scope and sequence into existing courses. Appended are an abbreviated curriculum module on the ecosystem, a case study model on solid waste management, selected activities from issue investigation and citizen action training, a glossary, and a bibliography of 69 items. (KR)

Unesco-UNEP International Environmental Education Programme

Environmental Education Series **29**

A PROTOTYPE ENVIRONMENTAL EDUCATION CURRICULUM FOR THE MIDDLE SCHOOL

A Discussion Guide for Unesco Training Seminars on Environmental Education



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Division of Science, Technical and Environmental Education

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Unesco-UNEP International Environmental Education Programme

Environmental Education Series **29**

A Prototype Environmental Education Curriculum for the Middle School

A Discussion Guide for Unesco Training Seminars on Environmental Education

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PREFACE

This document presents a prototype environmental education curriculum and important associated materials for the middle school. The organization of the document is intended to be simple and understandable. Because the curriculum described here (in Chapter III) is organized around a set of commonly accepted goals for curriculum development in the field, Chapter I focuses on those goals and their validity. In addition, in Chapter I the writers make an effort to put these goals into perspective for the curriculum developer.

Chapter II focuses on environmental education and the middle school learner. Using the goals presented in Chapter I, the writers have attempted to lay out options for dealing successfully with the heart of environmental education - the issues that citizens of all ages must learn to successfully cope with in their lives. Very specific suggestions are made with respect to the methods that can best make a middle school curriculum work for learners. Of major significance are methods associated with the use of the case study in environmental education and what the authors refer to as "issue investigation and citizenship action training". Other strategies referred to in Chapter II deal with such topics as the use of community resources, the effective use of field trips, role playing, simulations, and panel discussions.

Chapter III presents the prototype curriculum itself - in outline form. Basically, the three year curriculum is divided into three components: (1) ecological foundations, (2) environmental science and environmental health, and (3) issue investigation and citizenship action training. Two things appear important to mention with respect to Chapter III. These include: (1) The curriculum presented is extensive and thorough, perhaps too much so for many schools to implement. It is presented, instead, as an ideal around which a team of educational planners can make intelligent decisions about what their own curriculum should look like. (2) Even though the curriculum outlined here may exceed the constraints placed upon a given school or nation, all of the major components should probably be represented in one way or another. Most importantly, Year Three content must be dealt with in the school if changes are desired in learner populations. That is, if a school or nation wishes a learner population to become effective as citizen activists with respect to environmental issues, that population must be given the skills needed to accomplish this.

Chapter IV discusses the infusion of environmental content and skills into existing courses at the middle school level. Examples of infusion and team-teaching approaches are presented along with a detailed outline which offers suggestions for infusing Chapter III's scope and sequence into existing courses, i.e., science, health, social studies, math, language arts, home economics, and agriculture.

The extensive appendices are presented as models of what an implemented curriculum can look like, at least in part. The authors have made a serious attempt to provide models around which additional materials can be produced. This is particularly true with the case study which, in this instance, focuses on solid waste management. It goes without saying that many, many issues can be taught via the case study format, using the instructional components found in this model.

The document ends with a rather thorough glossary and bibliography, both designed to be of help to the reader. The curriculum developer should find many of the references in the bibliography to be of enormous help in planning for instruction.

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CHAPTER I

EE GOALS AND CURRICULAR CONCERNS

INTRODUCTION

The purpose of this document is to describe a three-year course of study for the middle school student. Although the "middle school" is interpreted differently in various countries and various school systems, the middle school student is usually somewhere between the ages of ten and fifteen. These years are important developmentally as the individual approaches adolescence and prepares for the role of an adult citizen in society.

The environmental education (EE) curriculum described here is designed to aid middle school youngsters in developing "environmental literacy". Environmental literacy should be regarded as the ultimate aim of EE. A description of the ultimate aim of EE, paraphrased from Harvey (1977), is presented below.

THE ULTIMATE AIM OF EE

. . . to aid learners in developing into citizens who possess the knowledge, skills, and attitudes which enable and encourage them to engage in environmentally responsible behaviors.

The potential for accomplishing this educational aim will be greatly enhanced if planners have in place a set of goals to aid in curriculum-related decisions. Thus, the writers have chosen to base the framework of this document (and of the curriculum it describes) on a cohesive and valid set of goal statements for EE, which has been shown effective in changing learner behavior when implemented through well developed curricular programmes.

The goals on which this document are based are modified from those developed by Hungerford, Peyton, and Wilke and published in 1980. These goals were written to be consistent with the categories of objectives included in the Tbilisi Conference Report (1978), and encompass four levels of cognitive knowledge and skills within the broad scope of environmental literacy: 1) ecological foundations; 2) issue awareness; 3) investigation and evaluation; and 4) issue resolution. The first two goal levels, foundations and awareness, focus on conceptual awareness of ecological principles and of environmental issues. The latter levels include goals which deal with the development and application of skills prerequisite to investigating and evaluating environmental issues, and to participating in the remediation of those issues.

Thus, these four goal levels should be viewed as hierarchical and considered as such when infused into instructional programs for learners. The four goal levels, and their attendant goals are presented on the following pages.

GOALS FOR CURRICULUM DEVELOPMENT IN ENVIRONMENTAL EDUCATION

GOAL LEVEL I
THE ECOLOGICAL FOUNDATIONS LEVEL

Upon completion of instruction in environmental education, the learner should be expected to be able to . . .

1. . . . communicate and apply the major ecological concepts including those focusing on individuals, species populations, communities, ecosystems, biogeochemical cycles, energy production and transfer, interdependence, niche, adaptation, succession, homeostasis, and man as an ecological variable.

2. . . . apply a knowledge of ecological concepts to the analysis of environmental issues and identify important ecological principles involved.

3. . . . apply a knowledge of ecological concepts in predicting the ecological consequences of alternative solutions to environmental problems.

4. . . . understand the principles of ecology in order to identify, select and utilize appropriate sources of scientific information in a continuing effort to investigate, evaluate and find solutions for environmental issues.

GOAL LEVEL II
THE CONCEPTUAL AWARENESS LEVEL

5. . . . understand and communicate how man's cultural activities (e.g., religious, economic, political, social and others) influence the environment from an ecological perspective.

6. . . . understand and communicate how an individual's behaviors impact on the environment from an ecological perspective.

7. . . . identify a wide variety of local, regional, national and international environmental issues and the ecological and cultural implications of these issues.

8. . . . identify and communicate the viable alternative solutions available for remediating crucial environmental issues as well as the ecological and cultural implications of these various solutions.

9. . . . understand the need for environmental issue investigation and evaluation as prerequisite to sound decision making.

10. . . . understand the roles played by differing human beliefs and values in environmental issues and the need for personal values clarification as an important part of environmental decision making.

11. . . . understand the need for responsible citizenship action in the solution of environmental issues.

GOAL LEVEL III
THE INVESTIGATION AND EVALUATION LEVEL

12. . . . apply the knowledge and skills needed to identify and investigate issues (using both primary and secondary sources of information) and synthesize the data gathered.

13. . . . demonstrate the ability to analyze environmental issues and the associated value perspectives with respect to their ecological and cultural implications.

14. . . . demonstrate the ability to identify alternative solutions for important issues and the value perspectives associated with these solutions.

15. . . . demonstrate the ability to evaluate alternative solutions and associated value perspectives for important issues with respect to their ecological and cultural implications.

16. . . . demonstrate the ability to identify and clarify personal value positions related to important environmental issues and their associated solutions.

17. . . . demonstrate the ability to evaluate, clarify, and change value positions in light of new information.

GOAL LEVEL IV
THE ISSUE RESOLUTION SKILL LEVEL

18. . . . demonstrate a competence with a variety of citizenship action skills from the following categories of skills: persuasion, consumerism, political action, legal action, and ecomanagement.

19. . . . evaluate selected actions in light of their ecological and cultural implications.

20. . . . demonstrate the ability to apply one or more citizenship action skills for the purpose of resolving or helping to resolve one or more environmental issues.

TOPICS RELATED TO THE GOALS

Readers are not asked to accept the goals as stated above without questioning their validity and utility. Similarly, there are other related topics of importance that should be addressed to help professionals view these goals as desirable (or undesirable as the case may be) for use in their particular educational situations. Validity considerations will be discussed in the following section as will other topics associated with the goals and their use.

Validity Considerations

In an effort to assess the content validity of the goals, the goal developers compared the goals expressed at each of the four levels (i.e., ecological foundations, conceptual awareness, investigation and evaluation, issue resolution) with the five categories of environmental education objectives proposed at the Tbilisi Conference. To make the comparison, the developers constructed a two-axis comparison grid. Using this grid, the de-

velopers independently analyzed each goal, and identified where an interface existed with the Tbilisi objective statements. Following this individual assessment, the developers met together to synthesize the individual analyses. They discovered that the goals bore a marked correspondence with the Tbilisi objectives. Observing this agreement, the developers inferred a substantial degree of content validity for the goals as originally written.

Subsequent to the developers' initial content validity assessment, they submitted the goals to a validity panel consisting of seven nationally (USA) recognized environmental educators. Validity panelists were asked to respond to a series of questions which would rigorously inspect the goals and their validity. Completed validity assessments were received from five of the seven panelists. In general, the comments received from the panelists were consistent. The goals were revised in accordance with the panelists' comments and considered valid.

The goals were published in 1980 along with a detailed statement of the assumptions made by the developers. The stage was thus set for the goals to be used in a variety of ways by professional environmental educators and curriculum developers at all levels. Interestingly, the goals have, indeed, been widely used in the field, which further establishes their validity. A brief description of some of these uses follows.

Use of EE Goals in Research and Literature

Since their development, a major use of the EE goals has been in the area of research. Numerous studies have utilized the goal levels as an organizational framework or have directly investigated outcomes related to one or more of the goal levels.

Among those studies which used the EE goals as an organizational framework are those of Gardella (1987), Stevenson (1986) and Volk, et al. (1984). Gardella's research focused on the development of an instrument wherein the EE goals were among the criteria employed in assessing EE curricula. Stevenson, interested in an analysis of popularly used curricula in Australia and the U.S., also used the goals as criteria. In their national assessment of EE curricular needs in the U.S., Volk, et al. surveyed the responses of professional environmental educators on a number of curricular variables relative to the goals.

Although these three studies were dissimilar in method and purpose, the researchers derived conclusions which were strikingly similar. In general, they found that content and activities associated with the lower goal levels (i.e., ecological foundations and issue awareness) were much more prevalent in curricular materials and practice than were those which addressed the higher goals (i.e., investigation/evaluation and issue resolution). Interestingly, those findings are consistent with Childress' (1978) study of EE curricula used in U.S. schools.

Volk, et al. also found a high degree of agreement among formal and nonformal educators relative to the importance of these EE goals across academic levels (elementary through tertiary). This consistency of agreement in a national sample further attests to the validity of these goals for EE.

A second body of research includes studies which directly investigated outcomes related to one or more of the goal levels. In studies by Klingler (1980) and Ramsey, et al. (1981), an EE program based on the goals was implemented in middle school classrooms and an attempt was made to ascertain whether such goal-based instruction did, in fact, elicit positive environmental behavior. The results of both studies strongly suggest that young-

sters who were allowed to develop and apply the knowledge and skills reflected throughout the four goal levels did initiate and participate in responsible environmental behavior to a greater degree than youngsters who had experienced only environmental awareness-oriented instruction.

More recent research by Holt (1988), and Ramsey (1987) used a revision of the program utilized in Ramsey's earlier work, and investigated the effects of such goal-based curricula on middle school learners. Criterion variables included overt environmental behavior, knowledge of environmental action (i.e., issue resolution) skills, perceived knowledge of environmental action skills, perceived ability to apply environmental action skills, individual locus of control, group locus of control, and environmental sensitivity. Both Ramsey, working with average to above-average middle school youngsters, and Holt, working with average to below-average students, found that youngsters who experienced the goal-based program made significant gains in overt environmental behavior, knowledge of environmental action skills, perceived knowledge of environmental action skills, perceived ability to apply environmental action skills, and individual locus of control. Thus, it would appear that these EE goals comprise a consistent, effective, and logical sequence from an instructional perspective. Similarly, programs based on these goals appear to be applicable to and successful with middle school students with a wide range of ability levels.

Also included within the research which investigated outcomes associated with goal levels are studies by Champeau, et al. (1980) and Peyton and Hungerford (1980). Champeau, et al. questioned elementary and secondary teachers regarding the educational importance of each of the goal levels and the teachers' self-reported ability to implement instruction relative to each level. This research indicated that most of the teachers surveyed viewed the goals as important components of educational programmes, but felt that they lacked both the training and the instructional resources to accomplish those goals.

Peyton and Hungerford chose to focus their research on the fourth goal level (action) and investigated the abilities of teachers (preservice and inservice) to identify, teach, and implement environmental action (issue resolution) skills. The sample of teachers in this study perceived that they had limited environmental action skills and very few reported an active involvement in environmental action. In general, these teachers felt that they could teach, but not prepare, environmental action materials.

One additional remark on the use of these goals in literature in the field seems appropriate. Several documents published through UNESCO have utilized Hungerford, Peyton and Wilke's goals as a basis for EE curriculum development (Hungerford & Peyton, 1986), as a basis in discussing competencies for EE teachers (Wilke, et al, 1980), and in the presentation of an EE teacher preparation program for elementary teachers (Hungerford, et al, 1988). Thus, these goals appear to be gaining acceptance on the national and international level, as a comprehensive framework for efforts in EE.

Comments on Environmental Action (Issue Resolution) in Education

Opinions differ on the role of environmental action (issue resolution) in formal education. There are those who require students to participate in environmental action related to particular issues. Still others take the position that educators should avoid any involvement in environmental issues (or other social issues) on the part of students. The writers disagree with both these positions, particularly at the middle school level.

At this educational level, it seems inappropriate to require students to take particular environmental actions, especially where those actions may well be contrary to a student's personal beliefs and value. It is appropriate, however, to direct students to acquire the skills of responsible citizenship action and demonstrate those skills in surrogate classroom situations. In keeping with the role of citizenship in a society, it seems responsible for a teacher to support student actions, if these actions are socially and ecologically responsible, but not to force students into acting in the community or region in which they live.

Therefore, it appears that there is an ethical responsibility on the part of educators to help students become skilled in citizenship roles but to defer to the student's own beliefs and values in terms of what the student chooses to do. In the final analysis it is critically important for the professional educator to make carefully thought out decisions concerning the role of environmental action and issue resolution in a given instructional programme.

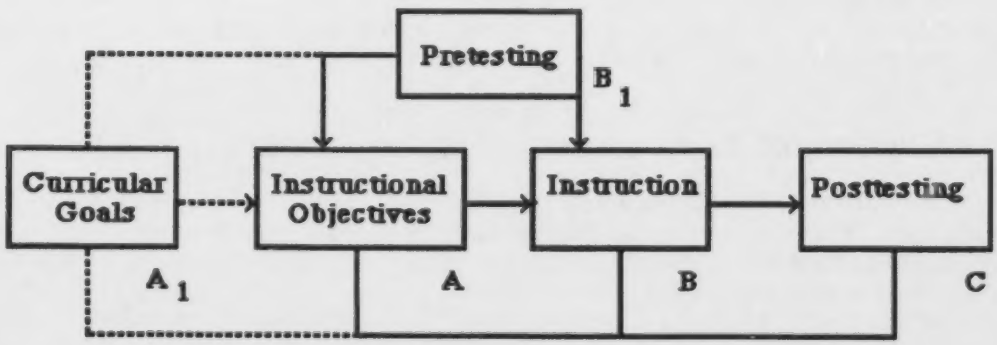
CURRICULAR PLANNING IN ENVIRONMENTAL EDUCATION

Planning for Instruction: The General Teaching Model

Regardless of the set of goals used by instructional planners, a functional instructional model must be applied in order to achieve any semblance of validity in the final product (e.g., the unit, module, activity, curriculum). To produce instructional products without serious consideration being given to the very act of instruction usually results in invalid, inappropriate, and inconsistent materials.

An instructional model which can be used for planning for instruction is diagrammed below and is called "The General Teaching Model". This diagram provides a model for the instructional planner which, if applied rigorously, can result in organized, internally consistent, and valid EE materials for any learner group. Further, it can be applied to any grade level and any content area. Of major significance is the fact that this model can be applied by teams of professional educators attempting to implement effective EE instruction for middle school learners.

The General Teaching Model



Parts A, B, and C of this diagram constitute the heart of instruction. Pretesting (B1) should be incorporated only when needed, i.e., there are times when a particular learner group, receiving a particular instructional package, will not need pretesting based on information already known to the instructor. Each of these major components will be briefly discussed below.

Instructional Objectives

Instructional (learner) objectives are critical to the entire process of instructional planning. This component establishes what the learner is to learn, i.e., what the instructor is to teach.

The selection of instructional objectives should be based on: (1) the goals being used, (2) the scope and sequence of the curricular materials being developed, (3) what behaviors the students are expected to demonstrate subsequent to instruction, (4) what the students' capacities are at the beginning of instruction, and (5) the resources available to the instructor.

Once the instructional objective is selected it should be inspected for consistency with the goal(s) being used. It should also probably be stated in performance terms in order to permit the instructor to measure its acquisition during or subsequent to instruction. Several examples of learner objectives appropriate for the goals referred to earlier in this document are stated in the following list.

The Goal Level	The Instructional Objective
Ecological Foundations	Subsequent to the unit on homeostasis, the students will visit a local, stable ecosystem and cite at least three (3) variables which contribute to the homeostatic nature of that ecosystem.
Issue Awareness	Following a unit on man's cultural activities and the environmental implications of these activities, students will be able to state two (2) ways in which regional ecosystems are threatened by man's activities.
Investigation and Evaluation	After completing a unit on investigation using secondary sources, the students will draw an issue (from a set of issues prepared by the instructor) from a container and locate at least six (6) published references dealing with that issue.
Issue Resolution Skills	Students completing instruction on environmental action will be able to write a suitable definition for consumerism and cite at least two current issues that could possibly be influenced by that mode of action.

The benefits of using performance-based learner objectives are many. A few of these benefits follow: Performance-based learner objectives . . . (1) . . . contribute to the logical sequencing of content, (2) . . . contribute to effective communication concerning expected outcomes between instructional planners and their students, (3) . . . help

provide a mechanism whereby both instruction and curriculum can be evaluated, (4) . . . promote efficient learning when students realize what is expected of them, (5) . . . facilitate pretesting when this component is being used, and (6) . . . help evaluators and researchers measure the acquisition of particular goals.

Pretesting

Pretesting is undoubtedly of great value when an instructor is beginning a new unit or commencing to work with a group of unfamiliar students. When used, pretesting should involve an evaluation of the extent to which students have already mastered the performance objectives reflected in the instructional package to be implemented. Pretesting must be consistent with the objectives and anticipated instruction if it is to be of value. In situations where the instructor is thoroughly familiar with the learners - or where courses are very sequential in nature - pretesting for every unit/module may not be necessary.

Instruction: Content and Methods

This component involves the selection of the content most appropriate for enabling students to master the objectives in question. Also involved are the selection of suitable methods, the selection of instructional materials to be used, and the sequencing of activities used in instruction.

Content used for achieving particular goals will vary in different countries, or in different regions within countries. Certainly, schools surrounded by tropical rain forest should learn the concepts associated with "ecosystem" by interacting with the rain forest. It is foolish to ignore the student's own regional biome and focus on another distant region. Similarly, environmental issues vary from region to region and those of immediate concern to the students should be used, at least initially, when instruction is being planned.

Availability of instructional materials will also differ from school to school and region to region. Some schools will have access to many visual aids while another does not. The same is true for library resources, access to the representative biome, resource people, and laboratory facilities. These considerations must be kept sharply in focus when planning for instruction. This is not to say, however, that an instructional planner should not do everything possible to circumvent what appears to be a lack of available instructional resources.

Modes of instruction are critically important. The best available methods should be employed when designing and implementing instructional materials. A field trip may prove eminently more profitable than a lecture about a resource. Debate may provide considerably more opportunities for students to consider their own values than does simply reading about an issue. A laboratory may well teach far more about an ecological principle than a discussion about that principle. Methods can make the difference between a powerful learning experience and one that fails to result in the acquisition of desired knowledge, skills, or attitudes **(See Chapter II for a discussion on methods appropriate for use in the middle school)**.

Posttesting

Posttesting is probably a poor term to describe all of the attributes of this component because it infers that evaluation will take place upon the completion of the unit or module. In addition to terminal evaluation, many objectives can and will be evaluated enroute, as students progress through the learning sequence. Many affective objectives, for example, can be evaluated by the instructor's observation of learner behavior during a variety of activities, e.g., the student's involvement in the values clarification process during a debate, an issue analysis activity, or a simulation.

Still, many objectives will be evaluated subsequent to instruction. Regardless of when evaluation takes place, the critical thing to keep in mind is to guarantee that students are evaluated on the objectives as stated, in a manner consistent with instruction. Herein lies a much too common problem in education, that of preparing objectives, providing instruction, and then evaluating learners on some other set of objectives.

If the performance-based objectives have been carefully prepared and clearly stated, evaluation becomes a relatively simple matter. Of course, the evaluation mode or strategy will depend entirely on the way in which the objectives have been stated, i.e., the evaluation instrument will measure what the objectives specify as appropriate learner behavior following instruction. For example, an objective which asks for a description of an object or event should not be evaluated via a multiple choice test instrument. And, conversely, an objective that demands that a student be able to choose the correct response from a number of responses cannot be evaluated via an essay question. Consistency of evaluation is critically important. Further, the instructional planner should consider how evaluation will have to proceed when he/she writes objectives in the first place.

Oftentimes educators infer that the evaluation process is measuring only student success. This is partly true. However, posttesting is also a remarkably good indicator of the suitability or success of the instruction itself, particularly if the objectives and instruction are sound. Posttesting is also a powerful mechanism for establishing the need for revision in either the objectives or instruction or both. When revision is called for (and it will often be indicated), it should be undertaken promptly and with careful planning.

CHAPTER II

ENVIRONMENTAL EDUCATION AND THE MIDDLE SCHOOL LEARNER

Chapter II of this document focuses on the middle school learner and on instructional strategies which are appropriate to that individual. Specifically, this chapter will explore (1) the characteristics of the middle school learner, (2) instructional approaches associated with the teaching of issues - especially those approaches which are designed to lead to changes in learner behavior and, more importantly, citizenship responsibility, and (3) methods and resources appropriate for instruction at each of the EE goal levels.

THE MIDDLE SCHOOL LEARNER

The middle school phenomenon gained prominence during the middle and latter portions of the twentieth century. Middle schools, or middle level schools assume various grade level configurations (5-8, 6-8, 7-9, etc), often dictated by local conditions. Regardless of their grade level composition, these schools share the common purpose of providing a "transitional" education, i.e., the middle school serves as a transitional unit between childhood education and later adolescent education.

Thus, the middle school concept recognizes the special and unique needs of individuals standing on the threshold of puberty, individuals who are no longer children and not yet adolescents. What are characteristics of the middle school learner? And what are the instructional implications of those characteristics?

Although physical, emotional, and social characteristics are factors in learning, the following discussion will focus on the intellectual aspects of the emerging adolescents. The length of this document precludes a thorough examination of the developmental aspects of the young adolescents and the reader is referred to the bibliography of this document for further writings in this area.

A major intellectual characteristic of the emerging adolescent is the progression from concrete to operational thinking. This transition has been extensively explored and documented by Jean Piaget and others. Concrete and formal are terms which refer to mental structures used to manage thinking. A general structure that continues for an extended period of time (usually years) is referred to as a stage. The order in which the structures emerge appears to be identical from individual to individual. However, the age at which a specific structure emerges and the duration of that stage may vary from person to person. It is important to note that an individual does not obtain a new structure by being taught. Rather, each individual "invents" his/her structures through experiences. As individuals perceive more and more of the world, their systems for managing their intellectual lives (i.e., making sense of the world) must change progressively to handle new demands. Thus, new structures emerge from previous ones.

Middle youngsters may be capable of either formal operational or concrete operational thinking. Some youngsters, however, may still be in the pre-operational stage. Still other youngsters may be in transition between two of the stages. Thus a middle school

classroom might very well contain youngsters who vary drastically in their abilities and approaches to thinking.

Another hallmark of the middle years is the development from an egocentric to a sociocentric perspective. Very young children regard themselves as the center of their universes. Events, objects, and other people have meaning only in relation to the youngsters' own needs and interests. The movement away from egocentrism (not to be confused with egotism or selfishness) extends throughout childhood and is called decentering. By this is meant the progression of thinking that leads an individual toward a sociocentric view of the world, toward a sense of community and one's own membership in society. It appears that the principal factor that liberates an individual from egocentrism is social interaction - especially social interaction with peers. Interaction with others enables youngsters to learn other points of view, whether or not they can rationalize or agree with them.

Young children are egocentric in time and space, as well as in other ways. Toward the beginning of the middle school years, the emerging adolescent shows little sense of history and is limited in the ability to project extensions of a present event or condition into the future (George & Lawrence, 1982). As the individual develops, he/she gains the realization that personal histories affect present behavior, and that the future depends, at least in part, on choices made in the present. Thus, the stage is set for the consideration of consequences and implications of decisions and choices.

As the individual progresses toward adolescence, still another capacity is developed - the disposition to examine the logic and consistency of one's beliefs, of one's set of explanations of the world, and of one's assumptions that guide behavior. As youngsters examine their own beliefs and contrast them to the beliefs of others, they will begin to see contradictions or instabilities. Consistency and stability will gradually emerge only when individuals realize that there are general principles and that those general principles extend beyond specific cases. This process is probably necessary in order for the individual to progress from a reliance on slogans toward the construction of a personal ideology, or set of beliefs and values.

The development of a personal ideology is probably related in some way to the individual's recognition of the complexities of human motivation. Young children do not conceive of motivation or intention as being different from the act. Motivations do enter into the thinking of the emerging adolescent, however, and this understanding is gradually deepened. Scholars of cognitive development suggest a process which individuals go through as their understanding of human motivation is deepened:

> . . . as children are helped to reflect on their own experiences, particularly their interactions with others, they come to see that their behavior is influenced by many forces, present and past. When they see that their own actions have complex explanations, they begin to imagine that other people have complex motivations as well. By being helped to "take the point of view of the other" through role-playing or less structured means, they gradually are able to attribute to others motives they recognize in themselves (George & Lawrence, 1982, p. 53).

The middle school learner is indeed a complex entity. The developmental characteristics appear to follow similar patterns in individuals. Their rate of development, however, will probably vary considerably from individual to individual. What are the instructional implications of these developmental characteristics? The following table by Wiles and Bondi (1981) summarizes the intellectual characteristics of the emerging adolescent and the instructional implications associated with those characteristics.

Intellectual Characteristics	Instructional Implications
Emerging adolescents display a wide range of skills and abilities unique to their developmental patterns.	A variety of materials and approaches in the teaching-learning process should be utilized in the middle school
Students will range in development from the concrete-manipulatory stage of development to the ability to deal with abstract concepts, The youngster is intensely curious and growing in mental ability.	The middle school should treat students at their own intellectual levels providing immediate rather than remote goals. All subjects should be individualized. Skill grouping should be flexible.
Middle school learners prefer active over passive learning activities; prefer interaction with peers during learning activities.	Physical movement should be encouraged with small group discussions, learning centers, and creative dramatics . . . . Provide a program of learning that is exciting and meaningful.
Students in the middle school are usually very curious and exhibit a strong willingness to learn things they consider to be useful. Students enjoy using skills to solve "real-life" problems.	Organize curricula around real-life concepts. . . . Provide activities in both formal and informal situations to improve reasoning powers. Studies of the community, environment are particularly relevant to the age group.
Students often display heightened egocentrism and will argue to convince others or to clarify their own thinking. Independent, critical thinking emerges.	Organized discussions of ideas and feelings in peer groups can facilitate self-understanding. Provide experiences for individuals to express themselves by writing and participating in dramatic productions.

INSTRUCTIONAL APPROACHES ASSOCIATED WITH THE TEACHING OF ISSUES

Perhaps the major content area associated with environmental education (EE) is that of environmental issues. Similarly, given the unique developmental characteristics of the middle school learner, it seems appropriate to focus instruction on real-life problems and on the encouragement of independent, critical thinking. It would appear that a major and recommended focus might be that of environmental issues and alternative solutions . . . their identification, analysis, investigation, evaluation and eventual remediation.

What is an environmental issue? Perhaps the simplest definition is as follows: **"An environmental issue is one which has its roots in the environment and involves a problem surrounding which there are differing beliefs and values."** Examples of issues fitting this definition would include (but certainly not be limited to): human population growth, land-use management, nuclear waste disposal, ground water contamination, endangered species, tropical rain forest destruction, clear-cutting in temperate forests, desertification, marine fisheries management, loss of non-renewable energy resources, pesticide use and food production, depletion of fossil water aquifers, wetlands conversion to agriculture and human habitation, recycling, solid waste dis-

posal/management, non-point water pollution, air pollution, noise pollution, nuclear power generation, and loss of genetic diversity in food crops.

The writers have established two rules which govern the identification of an environmental issue: (1) it must truly be an issue, i.e., people must, at some point, disagree concerning the status or resolution of the issue (differing beliefs and values are present), and (2) it must have social and/or ecological significance and be related, in some dimension, to the environment. Given that a problem/issue meets these criteria, one can assume that an environmental issue has been identified.

Outcomes of Issue Instruction

Certainly, a major goal for environmental education is to develop a human being who can become an effective citizen in the world community and be able to contribute to the solution of environmental issues. This goal demands a number of prerequisite skills. These include: (1) the ability to identify environmental issues, (2) the ability to analyze issues and correctly identify the "players" (individuals or groups involved in issues) and their beliefs and values, (3) the ability to investigate issues in a manner as to identify the facts surrounding them and their proposed solutions, along with their social, economic, political, legal, and ecological ramifications, (4) the ability to evaluate issues and to determine the most effective means of resolving them, (5) the ability to develop an "action plan" which can be implemented in an attempt to resolve or help resolve a particular issue, and (6) the ability to execute an action plan if that plan is consistent with his/her personal values.

These are not instructional objectives familiar to most instructors, are they? And yet, these skills are ones which would serve tomorrow's citizens well. Meeting these instructional objectives, however, may not be an easy task and will probably necessitate a great commitment on the part of the professional education community and EE instructors specifically. If we look at the body of research concerning issue instruction, some very important findings become apparent. These include:

1. Although textbook coverage of issues is on the increase, there is a lack of issue coverage available for use by the teacher. Where issue coverage is present, it tends to be at an awareness level, without opportunity for indepth student investigation of issues or training for citizenship responsibility.

2. Issue instruction is not a pervasive arena for instruction in today's classrooms. Where it is found, it remains, by and large, an awareness activity. Thus, the really critical outcomes associated with issue instruction are not being realized.

3. If citizenship performance is a desired state for students, it will not be attained by teaching issues at an awareness level. If we want future citizens to be responsible citizens we must teach them how to be responsible.

It appears, then, that issue instruction must transcend a simple awareness of issues and incorporate direct training in citizenship skills associated with issue remediation. The writers are also of the opinion that, when indepth investigation skills are taught along with citizenship issues action skills, substantial citizenship behavior will result.

With these thoughts in mind, the writers recommend four "Instructional Levels" to be used in issue instruction. These instructional levels parallel the goal levels described in Chapter I. However, the goal levels which follow are focused on issue instruction specifi-

cally, rather than the environmental education curriculum The four "Instructional Levels" follow:

Instructional Levels for Issue Instruction

Level I: The Foundations Level
This instructional level provides learners with the prerequisite scientific knowledge (content) needed to understand and investigate the issue(s) in question.

Level II: The Issue Awareness Level
This level provides learners with the conceptual knowledge associated with discrete issues. It involves an understanding of the "anatomy of issues" including what separates problems and issues as well as the varying beliefs and values held by societal members which impinge so heavily on the origin and resolution of issues. At this level, students also become involved in analyzing the ecological and social/cultural implications of issues and solutions (e.g., economic, political, legal consequences, etc.). This goal also involves students understanding the need for them to become involved in issue investigation, evaluation, and resolution.

Level III: The Investigation and Evaluation Level: Training and Application
This level provides learners with the knowledge and skills necessary to permit them to investigate/analyze issues and evaluate alternative solutions for resolving these issues. It also involves some form of student involvement in the investigation process, including data collection, interpretation, and communication.

Level IV: The Issue Resolution Level: Training and Application This level provides learners with the skills necessary for making responsible decisions concerning the resolution of environmental issues. Likewise, it provides learners with an opportunity to prepare and evaluate "action plans" for issue resolution. Additionally, it supports the application of citizenship action strategies if and when students are motivated to apply their action plans.

Two Options for Dealing with Environmental Issues

It appears as though there are two promising and educationally viable options for dealing with issues in the middle school. One of these options rests with the development and presentation of case study units in science and social studies classrooms. The other focuses on training students to actually investigate issues on their own and on providing opportunities for such investigation. Both of these options can allow for indepth issue coverage. However, there are advantages and disadvantages associated with each of the approaches.

The Case Study Format of Issue Instruction

The case study is, by and large, a teacher-directed analysis of particular environmental issues. It is an instructional method which utilizes both primary and secondary sources to deliver issue-focused information and skills to students. These sources are, at least initially, used by the teacher to aid students in developing a foundation of knowledge concerning the issue. Once students are oriented to the issue, the teacher leads the students in an investigation of the issue on a class or small-group basis. Such a strategy could involve the students in a search of additional secondary sources of information, searching, perhaps, for new data sources that could be synthesized by the class. Or, it could involve a class decision concerning information needed or questions needing answering at the local/community level.

If the instructor/class decides that primary information is needed, this could lead to the development of survey instruments (questionnaires and/or opinionnaires) and the production of an instrument that the entire class could administer in the community/area. Of course, this would lead to the collection of primary data which would be recorded and interpreted by the class. Once class decisions are made concerning what should be done with respect to the issue, the time has come for considering the potential for issue remediation and the eventual development of an action plan which may or may not be implemented (depending on decisions made by the instructor/class).

The case study provides the teacher with a substantial amount of flexibility and control. The extent to which the issue is dealt with is in the hands of the teacher. The teacher can choose the issue, determine the methods to be used, make decisions concerning the depth to which the issue will be studied/analyzed, select the exact point at which the case study will be infused into the existing curriculum, and determine the length of time to be spent on the case study.

There is, however, a price that must be paid for flexibility and control! The costs involve time, energy, and skill in putting the case study together. Most issue case studies are a "do it yourself" curriculum with the instructor as the curriculum designer. Although students can be involved in the selection of a case study, that responsibility generally rests with the instructor. So, too, does the responsibility for finding and selecting sources such as printed matter, video tapes, guest speakers, panel discussion members, films, field trips, or simulation activities. Handouts must be prepared. Evaluation instruments must be designed. The development of a good case study is certainly not an easy task.

The Investigation Skill Approach for Dealing With Issues

The case study approach to issue investigation focuses on only one issue category at a time, e.g., the management the African elephant. The issue itself is the intent of case study instruction. As a result, the instructional activities are issue specific. In contrast, the investigation skill method employs a broader, more generalizable approach to the process of issue investigation. The intent of the investigation methodology is to develop in students the skills involved in issue investigation and resolution so that they can be applied throughout life. Unlike the case study approach, this method provides for the definition, practice, and application of knowledge and skills needed by learners to independently investigate and resolve issues.

Investigation/evaluation skill development builds on the awareness level and proceeds through to the action level. Students learn to differentiate between environmental problems and issues and, in so doing, gain a very important understanding concerning the nature of environmental (social) issues, i.e., people disagree about their resolution, and those disagreements are based on differing beliefs and values related to issues. That understanding provides the basis for the development of a critical skill, that of issue analy-

sis. This ability to analyze issues involves the identification of the different individuals or groups of individuals (players) involved in a discrete issue, and of the positions taken by those players regarding issue resolution. Also involved in issue analysis are the identification and comparison of the beliefs about the issue held by these players, as well as of the values implied by their belief statements. The ability to analyze issues also includes the identification of the implications, or consequences of issues and of their proposed solutions. Important consequences would include those which are ecological, as well as those which are social, political, economic, cultural, legal, and so on. Thus, issue analysis provides the learner with a mechanism for understanding complex social and environmental issues. As such it is a potent organizational tool for the learner.

As was stated above, a major purpose of this approach is to develop an autonomous (independent) investigator. In order to accomplish that end, important skills which must be developed involve formulating problem questions, identifying sources of information to answer those questions, and designing strategies to attain that information. Simply put, the learner must become skilled in answering questions such as: what do we need to know about the issue; where can we get that information; and how can we get it?

In order to gain those skills, learners are given the experiences of researchers. Subsequent to learning how to generate research questions, they are taught to effectively utilize both primary and secondary sources of information in the investigation of issues. Locating and accessing information from appropriate agencies, resource people, and library sources are important aspects of information gathering. Additionally, learners become adept at analyzing information (and information sources) for bias. The ability to compare and contrast discrete pieces of information, and to identify the values and beliefs inherent in each are important and powerful analytical tools, and learners must be given opportunities to practice those skills on a variety of issue-related information.

Students also learn that primary information might be gathered through the use of interviews, or through instruments such as surveys, questionnaires, and opinionnaires. In training youngsters in the design and administration of survey instruments, an application component is essential. Thus, we cannot simply tell students <u>how to</u> design and administer instruments. . .we must also allow them to <u>become involved in</u> the design and administration of instruments. And, following the collection of data pertinent to the research question(s), the interpretation of those data must be attended to. Therefore, youngsters receive instruction and practice on generating logical conclusions and inferences, and on making appropriate recommendations based on the data collected, rather than on emotion.

Since a major purpose of this approach is to develop autonomous investigators, the writers encourage instructors to permit youngsters at this time to engage in an independent investigation into an issue of their own choosing. Such a thorough investigation is prerequisite to sound decision making in the environmental realm, and to responsible participation in citizenship action related to the remediation of environmental issues. To allow a learner to engage in independent investigation prior to his/her development of investigative abilities is foolhardy on the part of instructors. To refuse to allow an issue investigation at this point will certainly result in a weaker instructional effect. That is, it appears that this component is necessary in order to provide an opportunity for students to apply the varied and sophisticated skills which they have been taught, thereby reinforcing those skills. So too, as the writer have observed on numerous occasions, an autonomous investigation allows a students to make an "investment" of his/her talents, interests and time in a preferred issue. Not only do students become experts regarding that issue, but they also derive a sense of "ownership" toward that issue. This sense of ownership, or feeling of responsibility provides the impetus for action-taking in a positive manner.

Citizen action training, the final component of this skill development approach, seeks to develop individuals who are capable of making wise choices regarding appropriate and effective citizen behaviors and who are willing and able to apply those behaviors responsibly to environmental issue remediation. Thus, learners become familiarized with the methods of action at their disposal as citizens, and become skilled in the use of those actions. In the United States, those actions include ecomanagement, persuasion, consumerism, political action, and legal action. Moreover, decision making skills are sharpened as learners evaluate proposed actions with respect to their effectiveness and appropriateness, and with respect to the ecological, social, economic, political, and other cultural consequences of the proposed actions. Finally, learners are asked to formulate a plan of action which they might utilize in relation to the environmental issue which they have investigated. The instructor is also urged to provide learners with the encouragement and support to implement their action plans.

Thus, in the skill development model, learners develop the abilities to gather and evaluate information about environmental issues, to make sound decisions regarding appropriate environmental maintenance and remediation, and to take action as responsible citizens in helping to resolve environmental issues. This method, as with most instructional methods, has a variety of problems and limitations. Because it is a developmental approach, it requires careful sequencing and sufficient time, and may not easily lend itself to infusion into an existing curriculum. Educators have typically found that an entire eighteen week semester is needed to complete the learner objectives. The model is quite appropriate, however, to a team approach, where a science teacher, social studies teacher, and/or language arts teacher join forces, sharing the particular subject matter expertise of each. Interestingly, this team approach can shorten considerably the time needed for this model.

Further, classroom management techniques are critical in those aspects of instruction where the students are actually investigating a large number of different issues. Here the instructor must act as a facilitator between a variety of resources and the many students in the process of investigating issues. In particular, some instructors have found it difficult to make the transition from direct instruction to a role which demands advising and consulting. Allowing students to independently investigate environmental issues is sometimes viewed by teachers as an unfamiliar and threatening departure from "traditional" classroom management practices.

Comparing the Two Approaches

Both the case study and the investigation skill approach provide instructional strategies by which teachers can effectively deal with issue investigation. An example of the case study unit can be found in Appendix II. Similarly, a portion of the skill development approach is presented in Appendix III. Both strategies share similar instructional goals and activities but differ significantly in scope, teacher and student postures, instructional time demands, and a variety of other curricular and classroom management factors. The chart beginning on the following page compares the issue case study and investigation skill approaches across a number of educational variables.

The Case Study Format Comparison Chart vs the Issue Investigation Skill Development Approach

Educational Variable	Case Study	Skill Development
Characteristics of Students:		
1. Grade Levels	Recommended Gds. 4-12	Appropriate for Gds. 6-12
2. Student Role	A receiver of information independent and large group researcher	An autonomous, researcher; skilled in citizenship action skills
3. Ability Levels	Wide range of abilities	Average and above
4. Sense of "Issue Ownership"	Not necessarily the case	Typically, students have a strong sense of ownership
Characteristics of Instruction		
1. Issue Focus	Single issue treatment; issues most often chosen by teacher	Multiple issue treatment; issues chosen by students
2. Instructor's Posture	Initially, very traditional, subsequently as a facilitator/ consultant during class investigation	Traditional posture by role as a consultant and facilitator as students investigate numerous issues
3. Time Demands	Variable - depends upon the case study and the activities involved (2-6 weeks)	Typically, eighteen weeks, with one hour per day of instruction in middle school
4. Risk of Experiencing a Syntax Problem	High risk	Low risk
5. Need for Inservice Training	High need	Very high need
6. Potential for Infusion into Existing Programmes/ Courses	Very high potential	Moderate potential - requires separate time block
7. Team Teaching Potential	Moderate potential	Very high potential

Outcomes of Instruction:		
1. Knowledge of a Broad Range of Environmental Issues	Low	High
2. Process (Skill) Acquisition	Low-moderate	Very high
3. Citizenship Action Skill Acquisition	Typically, issue specific	A generic set of skills is acquired - high transfer potential
4. Citizenship Responsibility (Out-of-School Behavior)	Moderate behavior observed if instructor covers the skills	A great deal of behavior observed out-of-school
Materials:		
1. Source of Materials	Teacher constructed except for issue literature/films, etc.	Published materials are available
2. Expense	Relatively low, depends largely on the issue	Moderate if published materials are put into the hands of the students

OTHER METHODS APPROPRIATE FOR THE MIDDLE SCHOOL LEARNER

Regardless of the teaching model used for instructional purposes in EE, certain teaching methods and instructional resources will prove necessary in order for instruction to be maximally effective. Students cannot be expected to change their behavior and become effective and responsible citizens when only lecture and discussion are used in the teaching-learning process. For example, learners cannot be expected to investigate issues unless they have the skills needed for, and experience in, the process of issue investigation. Similarly, one would not expect students to be skilled and responsible decision-makers, unless they had become acquainted with decision-making processes and had been provided with opportunities to apply those skills

A brief overview of some of the methods and associated resources which are recommended for use with the instructional levels (described earlier in this chapter) is presented on the following pages. As noted, those instructional levels parallel the EE goal levels presented in Chapter I of this document. Following this methods/resources schematic, a few of the methods are discussed further.

Using a Goal-oriented Framework as a Basis for Organizing Instructional Methods and Resources*

Goal Level	Available Methods	Available Resources
Ecological Foundations	Field Studies/Local Local	Natural Areas, Refuges, Environmental Centers, Nature Centers, Etc.
	Simulations and Models	Computer Programmes, Diagrams, Printed Simulations.
	Viewing and Discussion	Video Tapes, Movies, Filmstrips.
	Reading and Discussion	Texts and Other Print Materials.
	Lecture and Discussion	Overheads, Worksheets, Lecture Notes, Followup Panel Discussions.
Conceptual Awareness	Field Trips	Local, Environmentally Impacted Sites, Sites of Issue Foci.
	Simulations and Models	Computer Programmes, Diagrams, Printed Simulations.
	Case Histories	Teacher Developed Case Histories,Print Materials, Community Resource People.
	Brainstorming (Problems, Issues &Solutions)	Teacher Organized Brain-storming Sessions.
	Viewing and Discussion	Video Tapes, Movies, Filmstrips.
	Reading and Discussion	Textual and Other Print Matter.
	Lecture and Discussion	Overheads, Worksheets, Lecture Notes, Followup Panel Discussion.
	Issue Analysis (Players, Positions, Beliefs, and Values)	Worksheets Involving the Issue Analysis Procedures; Films & Print Materials as Referents.

	Brainstorming of Alternate Solutions	Teacher Organized Brainstorming Sessions, Focus on Student Involvement.
Investigation and Evaluation of Issues	Secondary Source Investigations	Libraries and Other Collections.
	Primary Data Collection	Data Collection Instruments, Samples as Needed.
	Value Clarification/ Moral Education	Print Materials, Valuing Exercises.
	Role-playing and Simulations	Print Materials, Required Resources made Available.
	Panel Discussions and Debate	Print Materials, Required Resources made Available.
Environmental Action Skills	Skills Training Sessions	Print Materials and Exercises.
	Action Workshops	Community Resource Persons.
	Action Analysis	Worksheets Using the "Action Analysis Criteria".
	Student(s) Action Projects	Teacher and Resource Persons as Supervisors/ Consultants; Required Resources Made Available.
	Action Learning in Community Internships	Community Programmes and Projects, Cooperating Organizations.

***Adapted from a similar table by Tom Marcinkowski in Hungerford et al (1988).**

Inventorying and Using Community Resources

A few years ago one of the writers of this document had occasion to join a team of professional educators which was assigned the task of evaluating a rural secondary school in southern Illinois. This writer's specific responsibility was to inspect the curricular programme in the science department. One of the first things he noted was the school's setting. The school was out in the country. It was located on perhaps five acres of mowed grass, green from the moderate climate of the region. Just south of the school, no more than 100 yards away, was a large tract of oak-hickory deciduous forest, ungrazed and rich in ecological variables. In front of the school was a wide ditch which was water-soaked. In spots, standing water could be observed complete with plankton and associated water

insects and amphibians. Just across the highway lay a railroad track and beyond the railroad was a very large segment of the national forest which was part of the region. Seldom, if ever, had the writer observed a school with equally rich natural resources available within a five minute walk of the classroom. Excited with the prospect of finding an exciting science program for students, the writer observed several classes and spoke with the teachers in the science department. The biology teacher was interviewed last. He was quick to inform the writer that he didn't allow his students out of the classroom and, therefore, didn't use the resources which were so close to the biology room.

Unfortunately, this situation is far more typical than one would like to admit. We often refer to such a situation as a "two by four classroom", i.e., two covers of a book and four walls of a classroom. And, we are almost certain that students coming from such a classroom will have only limited ecological knowledge, will not be aware of the resources of their region, will not be able to investigate serious issues within the region, and will not know how to help resolve the important issues facing them and their community. This unfortunate state-of-affairs could be remediated, at least in part, by teachers using community/regional resources in their teaching.

A teacher (or teachers) can become acquainted with local/community resources through the development of a "resource inventory". A resource inventory is simply an inventory of the physical and human resources available for instruction within the teacher's own area. This inventory can take the form of a book or a manual, it can be computerized, or it can be developed as a card file to be used by all faculty members in a school.

Researchers have found that those teachers who actually get involved in the inventory process are the ones who will use those resources with their students to a far greater extent than other groups. Teachers who simply have access to a resource inventory (without any involvement in its development) tend to use the resources less.

What kinds of resources can be inventoried for an environmentally related resource inventory? A few examples would include resource people such as wildlife biologists, game wardens, botanists, commercial fishermen, trappers, hunters, waste disposal personnel, waterworks personnel, sewage plant operators, insect and rodent control specialists, greenhouse operators, environmental organization activists, and ranchers/farmers. Other examples would include physical resources such as wildlife refuges and parks, national/state forests, farms, ranches, typical ecosystems (biomes), zoos, fish hatcheries, sewage plants, waterworks, garbage dumps (landfills), electrical utilities, commercial airports, strip mines, fertilizer industries, toxic waste dumps, university facilities such as departments of fisheries and wildlife, local parks having environmental potential, environmental centers, and recycling centers.

Effective Use of Field Trips

In order to be maximally effective, the field trip should be task oriented. A simple "excursion" outside of the formal classroom is usually a total waste of time. Therefore, it is up to the instructor to provide the parameters needed to insure success. The "task" for the student can be one of several types. It can involve answering one important question in depth. It can involve some sort of inquiry which demands that problem solving skills be applied. It can involve a survey which necessitates the use of a data collection instrument. It can simply involve a student-generated description of something (e.g., an ecosystem) which is not available within the confines of the regular classroom.

Besides providing a definite task for the students on a field trip, several other considerations are important. Among these are:

1. Arrangements for transportation, if needed.
2. Plans for student safety.
3. A preliminary trip to make sure that the instructor is familiar with the resource.
4. Pretrip discussions with students about the nature of the trip, the resource and their assigned tasks.
5. Discussion concerning student deportment on the trip, i.e., expectations of student behavior.
6. Posttrip data recording and synthesis. Reports by individual students or small groups may be indicated.

Other parameters may be needed, depending on the nature of the trip. If the instructor is taking the class on a trip to the landfill, for example, students may be assigned an additional task of observing litter/illegal dumping along the route to the dump. Or, if the trip is to an excellent example of the dominant ecosystem (biome) the instructor may ask students to take notes on the way home on the ways in which man has modified the biome.

The solid waste management case study included in the Appendix of this document assumes, in part, that the instructor is interested in students taking a holistic look at the landfill, its environment, possible issues surrounding the site, alternative disposal methods, land reclamation, and citizen action if needed. A worksheet included in that case study unit provides students with an opportunity to synthesize a great deal of information back in the classroom and to participate in decision-making about the consequences of one type of human behavior as well as citizen action that might be called for.

Using Role Playing and Simulations

Simulations provide opportunities for individuals to explore the various players, positions, beliefs and values present in discrete environmental issues. Role playing permits the learner to "get inside" the issue as he/she assumes the role of a particular player and interacts with other players in attempting to resolve the issue. Although it requires some skill on the part of the instructor, this model has great potential for demonstrating the relevance of textbook information to real-life experiences. It also provides the students with practice in making important decisions and in developing action-oriented human relations skills. This type of socio-drama is probably an ideal activity for young adolescents, as it permits them to "try out" alternate beliefs and values and thus to test and validate their own beliefs and values.

Role playing can be conducting using either small or large groups. In the small group procedure, most of the class members will act as observers. Their participation occurs after the role players have made a decision, if time is set aside for discussion and comments. Often non-participating students are eager to comment on the decisions made by others, even if they lack the confidence to fully engage in role-playing. For these individuals, this procedure provides them with good modeling for future role-playing in which they might wish to participate.

Large group simulations, of course, have the advantage of full involvement by all class members. Simulations set in general meetings, such as town meetings, commissions, public hearings, etc., necessitate the roles of principal players, and of supporting players. An example of this large group simulation can be found in Wilke, Peyton, & Hungerford (1980). This simulation entitled "The President's Commission on Population", describes

a meeting of a presidential advisory commission on population policy, and includes the roles of principal players who will testify before the commission (e.g., economist, agriculturalist, Planned Parenthood representative, environmentalist, etc.). Also included within the simulation might be the roles of commission members themselves, who must make a decision related to the recommendation of a population policy.

Generally, this type of simulation includes the assignment (or selection of roles) and requires research and preparation on the part of class members. Students should understand in advance that role playing is no joke, that there will always be a specific agenda, and that a timetable will be strictly adhered to. This should help them to keep on task. They should be assured in advance that once the role-playing session is underway, no breaking of roles will be tolerated. The instructor, of course, must also resist the temptation to step out of role. In general, this breaking of role is time-wasting.

When describing the simulation, the instructor should be very clear about the decision(s) to be made. The nature of the decisions will cue students about the information they should gather and prepare. Students should be advised to consider what alternate decisions can be made, to discuss the alternatives in terms of information, the value perspectives of their roles, and their personal values, and then, to make a decision. The instructor should avoid provide a full outline of each player's position, if possible. Otherwise, the student might discuss what they feel the instructor thinks is important, rather than focus on their own research and thinking.

As in any large group activity, some students might be tempted to remain in an anonymous non-participatory role. Rubenstein and Slife (1987) recommend the following methods to facilitate equitable participation during a simulation:

> 1. When a participant speaks in a weak voice as though the comment or question is meant only for you, resist the temptation to get closer. Walk away, preferably putting other participants between you and the speaker, requiring raised speech volume and interaction within the group.
>
> 2. Be as mobile within the meeting room as possible. Mentally mark off the room into four quarters. After each contribution, turn to a different quarter of the room expectantly. Be prepared for an occasional elongated silence. Let it develop, unless there is a need to clarify the last remark.
>
> 3. Be sensitive as possible for the need for an occasional question or statement from you to quiet mounting anxieties or to explain or intensify someone's comment. Playing "devil's advocate" is often very productive, if done gracefully.
>
> 4. Limit your own contribution to that of management. Give participants no hint of what you think concerning proper values or correct decisions. Students should always be convinced that decisions are theirs to make (Rubenstein & Slife, 1987, p. 22).

Panel Discussions

Panel discussions and debates on environmental issues are excellent mechanisms for permitting students to present conflicting viewpoints and to evaluate the merit of different beliefs and values. In examining and evaluating various ideologies, adolescents are afforded an excellent opportunity to compare their personal ideologies to those of others.

The debate provides a formal procedure for discussing issues and is probably quite appropriate for the older middle school students. An excellent description of formal debate procedures can be found in Rubenstein & Slife (1987). The following information is also adapted from Rubenstein & Slife and will focus on a less formal discussion mode - the panel discussion.

A panel discussion can directly involve from two to ten students in active discussion and can indirectly involve the entire class. In general, it would be a good idea to plan a series of panel discussions on a variety of environmental issues. Students can then select an issue of interest to them and participate as panelists in discussing that particular issue. Major environmental issues should be identified by the instructor and an issue statement generalized for each issue. Note: it is best if this issue statement is in question form. A collection of articles and written information on each of the issues must be gathered together, and care should be taken that the major players/positions involved in each issue is well represented in the written material.

After the students select or are assigned to issue topics, they should become acquainted with all the material related to their topic which has been gathered by the instructor . They should also be encouraged to seek additional information which might be useful in discussing their issue. A week before the scheduled panel discussion, the students assigned to each issue are divided into two or more groups (enough groups to represent the major players involved in that issue). Although students do not know their "position" well in advance, they can still prepare for the discussion by surveying all available material, thereby becoming versed in their "opponent's" viewpoint as well as their own. Once positions are assigned, of course, the students representing that position must work together on their presentation of that position.

The panel discussion itself consists of four phases: presentation of positions, clarification of positions, free-form discussion, and audience participation. Each phase has a particular purpose and follows a prescribed structure.

Presentation of Positions

The purpose of this phase is to provide the audience (the rest of the class) with a general introduction to the issue and to state the major assertions associated with each position. Panelists on each team should outline beforehand the major points they wish to make so that they can approach this phase with clear and complete statements. Participants from each team alternate presentations, with the first presenter from each team having the responsibility of introducing their position in general. Subsequent presenters on that team then "flesh out" that position. It is advised that individual presentations begin with a concise statement of the main points being made by that presenter, followed by a brief summary in support of those points. Approximately one-third of the class period is usually sufficient for this phase.

Clarification of Positions

This phase is actually a question and answer session between the teams, and allows each side to clarify the other team's presentations and arguments. Only questions of clarification, not rebuttal or discussion, are appropriate during this phase. This phase is customarily rather short, perhaps five minutes.

Free-form Discussion

The first two phases should have "warmed" the panelists for the free-form discussion. Points, counterpoints, rebuttals, and general discussion are all appropriate. Panelists should be instructed to focus on the primary points of disagreement. Team members can prepare for this phase by identifying beforehand the main points (and supporting argu-

ments) they wish to discuss. They should also take notes during the other team's presentations in the preceding phase. This discussion phase is the major phase, with about one-half of the total class period allotted to it.

Audience Participation

In this final phase, the audience simply poses questions or comments to the panelists for response. It is advisable that questions be addressed to specific panelists, rather than to the entire group. This is simply because questions asked of the entire group are usually answered by the most vocal member(s), rather than by the individual who made the pertinent comment. As many different questions and comments as possible should be encouraged from the audience, and a free dialogue should be permitted. This phase may be continued as time and interest dictate.

CHAPTER III

THE THREE YEAR CURRICULUM: A DETAILED OUTLINE

Introduction

Chapter III presents a detailed three year outline of the recommended scope and sequence of an environmental education program for the middle grades. Each year will be presented separately.

For each year's program, a sample detailed instructional package is presented in the Appendices. These indepth samples are provided for curriculum developers to use as models. Certainly, these few examples do not constitute the entire spectrum of curricular strategies appropriate for the middle school EE program. Still, they offer serious examples of materials that correspond with the outline so as to demonstrate the feasibility of developing materials that correspond with the outline.

Curriculum developers may wish to know how the writers would recommend portioning time for the curricular outline. Therefore, for each major heading, percentages are shown which indicate the amount of time recommended for that heading. These percentages are suggestive only and should be viewed that way. The writers have also determined that certain content is more important than others. Importance is judged from both ecological and environmental perspectives. Therefor, any major heading showing a (##) notation should be viewed as critical and deleted only in the most serious of circumstances. A lack of the (##) notation gives the curriculum developer some latitude in case of severe time restrictions.

Earlier in this document the eventual involvement of the middle school student in serious issue investigation and citizenship responsibility was discussed. It is incumbent, therefore, on the curriculum developer who is faced with severe time constraints to make certain that much, if not all, of the third year's recommendations are kept intact. This admonition will certainly be a frustrating one for some but it is crucially important if the educator wishes to change student citizenship behavior in environmentally-appropriate dimensions.

YEAR ONE

ECOLOGICAL FOUNDATIONS AND MAN AS AN ECOLOGICAL FACTOR

I. What is Ecology? What do Ecologists Do? (05%)

A. Defining "ecology" (##)
   1. The science that deals with the interrelationships between plants and animals and their environment
   2. The term "ecology" derived from two Greek words which mean "study of the home"

a. Historical, naturalistic observations of plants and animals and their environment (natural history)
b. Modern, scientific observations of plants and animals and their environment (ecology)

B. The role of ecologists
1. The ecologist as a scientist
a. The accumulation of information about the interrelationships in the natural world
b. The accumulation of information about man's relationships with the natural world
2. The ecologist as a scientist who uses data to make predictions about the ecological (environmental) impact of man's activities
a. Impacts of man's urban development
b. Impacts of man's agricultural practices
c. Impacts of man's commercial and sport fishing practices
d. Impacts of man's mining and industrial practices
e. Impacts of man's energy production activities
f. Impacts of man's transportation practices
g. Impacts of man's recreational activities
h. The ecological impacts of man's other environmentally-related practices

II. Individuals, Populations, and Levels of Organization in Ecology (##) (07.5%)

A. The "individual" as one organism of a given plant or animal species
B. The "population" as a group of organisms of the same species living in a particular habitat (area) at a particular time.
C. The "community" as interacting populations of plants and animals living in a given habitat (area) at a particular time
1. Macrocommunities: the larger communities existing in relatively large habitats, e.g., an oak-hickory forest, a subtropical swamp, a short grass prairie
2. Microcommunities: small communities existing within larger communities, e.g., a fallen, decaying tree trunk, a temporary rain pool in a forest
D. The "ecosystem" as the community concept but with the added consideration of the nonliving environment (chemical and physical)
1. Life-related variables called "biotic" variables
2. Nonliving variables called "abiotic" variables
3. How living and nonliving variables influence each other
E. The "biome" as an aggregate of ecosystems with similar vegetative types
F. The biome, in reality, as one very huge ecosystem
G. Major biomes around the world
1. Deserts
2. Grasslands
3. Deciduous forests
4. Coniferous forests
5. Tropical rain forests
6. Freshwater
7. Marine
8. Tundra
H. Climate as the key variable in producing biomes

I. The "biosphere" as the composite of all earth ecosystems

III. The "Ecosystem Concept" Developed (##) (20%)

A. Importance of the ecosystem concept in ecology
B. Local/regional ecosystems
C. Components of ecosystems
    1. Biotic variables
        a. Food producers
        b. Food consumers
            1.) Herbivores
            2.) Carnivores
            3.) Omnivores
            4.) Decomposers
    2. Abiotic variables
        a. Physical factors, e.g., sunlight, shade, wind, precipitation, soil moisture, topography
        b. Biogeochemical factors, e.g.,
            1.) Carbon cycle
            2.) Oxygen cycle
            3.) Nitrogen cycle
            4.) Water cycle
    3. The critical nature of biogeochemical cycles
        a. Changing chemicals to forms available to living things
        b. The absolute need for waste reduction in natural living systems
D. Ecological niches in ecosystems
    1. The "niche" concept
    2. Various species' niches
        a. Food niche
        b. Reproductive niche
        c. Physical and chemical niche
        d. Habitat niche
    3. Difficulties in knowing an organism's exact/complete niche
    4. Specialized niches - defined/examples, e.g.,
        a. Panda
        b. Kirtland's warbler
        c. Limpkin
        d. Tick birds
    5. Generalist niches - defined/examples, e.g.,
        a. Man
        b. Fox
        c. Mouse
        d. Cockroach
    6. Specific examples of food-related niches
        a. Food producers
        b. Herbivores
        c. Carnivores
        d. Parasites
        e. Scavengers
        f. Decomposers
E. Competition in ecosystems
    1. Intraspecific competition: competition for resources within a species - between members of the same species

2. Interspecific competition: competition for resources between species - between members of different species
3. The "competitive exclusion principle" (no two species can occupy exactly the same niche in an ecosystem indefinitely)
    a. Importance of this principle for survival of a species
    b. Examples of closely related but separate niches, e.g., hawks and owls

F. Tolerance ranges and limiting factors in ecosystems
1. The "law of tolerance"
    a. The tolerance of an organism for the amount of a factor which falls above or below the optimum range for that species for that factor
        1.) Optimum range (for that factor)
        2.) Range of stress (for that factor)
        3.) Intolerance range (for that factor)
    b. Examples of factors which can impact on the "law of tolerance"
        1.) Water temperature
        2.) Air temperature
        3.) Insolation
        4.) Soil moisture
2. The "limiting factor principle"
    a. The one factor that is most lacking in an ecosystem that determines the presence or absence of a particular plant or animal
    b. Examples of factors that can be associated with the "limiting factor principle"
        1. Rainfall - tall grass species
        2. DDT - birds of prey
        3. Soil moisture - beech trees
        4. Acidity - bog plants

G. A summary of the ecosystem concept
1. Components of ecosystems
2. Ecological niches in ecosystems
3. Competition in ecosystems
4. Tolerance ranges and limiting factors in ecosystems
5. The importance of the ecosystem concept in ecology

Outline Vignette: The Ecosystem

No man, past or present, could possibly dream of - or create, even in fiction - living systems like naturally-occurring ecosystems. No one could envision systems so complicated, so interrelated, so dynamic, so resilient, so productive, so beneficial, or so terrribly susceptible to man's pervasive efforts to destroy them.

The Writers, 1988

IV. Energy and Ecosystems (##) (20%)

A. The need for energy to "drive" ecosystems
B. The sun as the source of energy for driving ecosystems
C. Green plants as the basis for energy production
1. The process of photosynthesis
2. How photosynthesis in green plants supports consumer organisms
    a. Food chains

1.) Energy transfers in food chains
2.) Examples from prominent ecosystems
a.) Terrestrial
b.) Aquatic
3.) Examples from local ecosystems

b. Food webs
1.) Energy transfers in food webs
2.) Food chains within food webs
3.) Examples from prominent ecosystems
4.) Examples from local ecosystems

c. The relationship of photosynthesis to man's food chains/webs

D. Energy losses in food chains
1. Energy lost at each step in a food chain: the 10-1 ratio
2. Energy loss vs the number of steps in a food chain
3. The concept of the "energy pyramid"
4. Energy implications of man's food chains

E. Net primary productivity in ecosystems: the rate at which the green plants produce energy minus (-) the rate at which they use energy
1. Using net primary productivity to evaluate the potential of ecosystems for producing basic food material for humans and other animals.
2. The net primary productivity of major ecosystems
3. The importance of ecosystems with high rates of net primary productivity
4. The difference between overall productivity and net primary productivity, e.g., the oceans with a low net primary productivity but a high overall productivity due simply to the extent of the ocean ecosystem.

V. Ecological Succession: Ecosystems Change Over Time (##) (07.5%)

A. Succession as a natural phenomenon
B. Succession as an orderly phenomenon with specific characteristics
1. Succession takes place over time
2. Successional stages are predictable
3. Ecosystems (communities) change from one kind to another
4. Ecosystems (communities) evolve, changing from less complex to more complex ones
5. Early successional stages create conditions which contribute to their own disappearance
6. The final community in succession is called the climax community

C. Major categories of succession
1. Primary succession
a. The sequential development of communities on a bare rock or soil-less surface
b. Often takes hundreds or thousands of years to complete
c. Examples
1.) On a volcanic lava flow
2.) On a rock surface after the removal of soil by erosion
3.) On surface mined land where soil has been removed
d. Midwestern (USA) primary successional stages:
1.) Bare rock to . . .
2.) Lichens to . . .
3.) Mosses to . . .
4.) grasses to . . .

5.) Shrubs to . . .
6.) Pioneer trees to . . .
7.) Climax tree species (the climax community)

e. Implications of man's activities for renewal of climax communities that have to develop via primary succession

2. Secondary succession
   a. The sequential development of communities where a soil layer exists
   b. Usually of shorter duration than primary succession - seldom over decades or centuries
   c. Examples
      1.) On abandoned agricultural land
      2.) Of a newly created farm pond or lake
      3.) On forest land that has been clearcut or burned, leaving a soil layer
      4.) On land stripped of vegetation for surface mining (soil remaining)
   d. Midwestern (USA) secondary successional stages on abandoned farm land
      1.) Annual weeds to . . .
      2.) Grasses and annual weeds to . . .
      3.) Shrubs mixed with grasses and annual weeds to . . .
      4.) Pioneer trees to . . .
      5.) Climax tree species (the climax community)
   e. The implications of man's activities for renewal of climax communities that have developed via secondary succession

D. A comparison of immature (early) and mature (late) successional stages
   1. Few niches - many niches
   2. Small plants - large plants
   3. Few species - many species
   4. Less complex - more complex
   5. Little resiliency - great resiliency

VI. Populations and Their Dynamics (##) (20%)

A. Species populations form communities
B. Characteristics of species populations
   1. Interacting members of the same species in a given area at a given time
   2. A reproductive unit of a given species
   3. Identifiable in terms of . . .
      a. Natality
      b. Mortality
      c. Immigration
      d. Emigration
      e. Population density
      f. Spatial distribution
      g. Age structure
C. The importance of the group (population) rather than individuals within the group
D. Interactions between populations
   1. "Commensualism"
      a. One species interacting with another where one is benefited and the other unaffected

b. Examples
1.) Spanish moss growing on oaks
2.) Barnacles growing on whales
3.) Poison ivy growing on the trunk of a forest tree

2. "Mutualism"
a. Two species interacting with each other where both are benefited
b. Examples
1.) Lichens: a fungus growing with algae
2.) Termites and flagellates
3.) The yucca and the yucca moth
4.) Beneficial bacteria in man's intestines

3. "Parasitism"
a. Two species interacting where one is benefited and the other harmed
b. Examples
1.) Ticks and mammals
2.) Tapeworms and man
3.) Mistletoe and junipers/oaks
4.) Bird lice and birds

4. "Predation"
a. one organism killing and consuming another organism
b. Examples
1.) Lion and antelope
2.) Ladybird beetle and plant lice
3.) Barn owl and rat
4.) Wolf and moose

E. Interactions within populations
1. Cooperation
a. Members of a given population cooperating with each other
b. Examples
1.) Group defense of territory, e.g., prairie dogs and warning cries
2.) Sexual contact, i.e., mating of males and females
3.) Aggregation, e.g., the flocking of Canada geese

2. Social behavior
a. Individuals of the same species participating in a division of labor (e.g., army ants, bees, termites)
b. Individuals of the same species developing a "social order" or "pecking order" (e.g., wolves. chickens, sea lions)

3. Competition
a. Individuals of the same species competing for survival essentials (e.g., space, food, water, nesting sites)
b. Competition as a mechanism that can lead to extinction

F. Population stability and instability
1. "Biotic potential" of a population, i.e., the rate at which a population would grow if all females bred as often as possible and all individuals survived past reproductive age
2. "Environmental resistance", i.e., the sum total of all environmental variables that tend to control the growth of the population
3. "Carrying capacity"
a. "Maximum carrying capacity", i.e., the maximum number of individuals that can be supported in an environment

b. "Optimum carrying capacity" , i.e., the number of individuals that can be supported in an environment without endangering the environment or the population itself

4. Cyclical populations
    a. Species populations that vary greatly in size from year to year or decade to decade
    b. Population fluctuations as normal events in ecosystems
    c. Examples of cyclical populations
        1.) The Arctic lemming: 2-3 year cycle
        2.) The Canadian lynx: 10 year cycle
        3.) Garden insects: 1 year cycle
5. Eruptive populations
    a. The J-curve phenomenon
    b. Organisms, finding and utilizing an unoccupied niche, erupting beyond long term carrying capacity
    c. Highly adaptable organisms, modifying their environment, erupting beyond long term carrying capacity
    d. Examples of eruptive populations
        1.) Unoccupied niches
            a.) Bacteria in culture medium
            b.) Deer in good habitat where predators have been removed
            c.) Algae in nutrient-rich environment
        2.) Highly adaptable organisms, e.g., man, coyotes
    e. The eventual response of an eruptive population to environmental resistance
    f. A population in decline after erupting and subsequent changes in carrying capacity
6. "Homeostasis", i.e., the concept of long term stability in cyclical populations over time

VII. Man As An Ecological Factor (##) (20%)

A. Man as a powerful ecological variable
    1. Tremendous adaptability - a very generalized niche
    2. Man's willingness to compromise the environment for economic gain
    3. Man's potential for environmental preservation/issue resolution
B. Man as an eruptive population
    1. History of the human population
    2. Man and the J-curve phenomenon
    3. Current population numbers
    4. Doubling time in human population growth
    5. A question of carrying capacity
C. The pervasive ecological consequences of erupting human populations - exploding populations vs finite resources
    1. Man as a builder of "communities" (towns and cities)
        a. A comparison of man's communities with naturally existing communities
        b. Habitat destruction/modification of man's communities
        c. The transport of food energy to man's communities
        d. Waste removal in man's communities
        e. Urban decay/crime/poverty

f. The relationship between human population and urban deterioration/slums
g. Potential solutions to urban problems
h. Reasons for the possible continuation/increase of urban problems

2. Man as a producer of food
   a. Man's agricultural systems
   b. Monobiotic agriculture
   c. Demands for commercial fertilizers, herbicides, and pesticides
   d. Consequences of man's food production
      1.) Point and nonpoint pollution
      2.) Groundwater contamination
      3.) Soil erosion
      4.) Soil compaction and salinization
      5.) Depletion of aquifers
      6.) Desertification
      7.) Amplification of toxic chemicals in food chains
      8.) Retrogression - succession in reverse

D. Man and the world's soils
   1. Impact of overgrazing
      a. Increased population in grazing societies and the concomitant demand for more animals - the "commons principle" at work
      b. Domestic animals and the degradation of grasslands
         1.) Declining plant species
         2.) Declining numbers of surviving plants
         3.) Invader weeds
         4.) Loss of entire ecosystems
      c. Possible solutions
      d. Why solutions are difficult
   2. Impact of row crop production
      a. Demand for more agricultural land
      b. Modification/destruction of habitat and existing ecosystems worldwide
      c. Loss of topsoil by erosion at a rate much faster than replacement
         1.) In the U.S.A., over one-third of farmlands losing productivity due to soil erosion
         2.) In developing nations, at least 25% of agricultural land losing topsoil at a rate which will result in a marked loss of productivity
      d. Loss of soil nutrients and replacement by commercial fertilizers

E. Man and the world's forests
   1. Man cuts and burns forests at an alarming rate
      a. To gain agricultural land
      b. For use as fuel
      c. For use as building materials
   2. Consequences of deforestation
      a. Excessive erosion rate of soil
      b. Decreasing water absorption capacity of soil
      c. Local climatic changes
      d. Loss of habitat for very large percentage of earth's plants and animals
      e. Desertification
   3. The relationship between expanding human populations and loss of forest land
   4. Possible solutions

5. Why solutions are difficult

F. Man and the world's wetlands
   1. Types of wetlands
      a. Swamps
      b. Bogs
      c Tidal marshlands/estuaries
      d. Flood plains/river bottoms
      e. Ponds
   2. Importance of wetlands
      a. Recharging areas for groundwater reserves
      b. Flood control
      c. Fishing production from coastal wetlands
      d. Life support system for migratory waterfowl
      e. Habitat for many plant and animal species besides waterfowl
   3. The status of wetlands in the U.S.A
      a. Half of all wetlands already lost
      b. Nearly 500,000 acres of wetlands lost annually
      c. Most wetlands drained for agricultural purposes
   4. International consequences of wetlands degradation

G. Man and the world's wildlife
   1. Wildlife defined as any undomesticated plant or animal found in naturally existing ecosystems
   2. Ecological importance of wildlife
      a. Maintaining the health and vigor of the earth's ecosystems
      b. Numerous benefits to the world's ecosystems
         1.) Food production
         2.) Oxygen production
         3.) Filtration of toxic substances
         4.) Climate moderation
         5.) Waste decomposition
         6.) Recycling of nutrients
         7.) Control of crop and disease pests
         8.) Storage of a vast reservoir of genetic materials
   3. Status of the world's wildlife
      a. Extinction rates
         1.) Before man: 1 species per 10,000 years
         2.) 1975: 100 species per year
         3.) 1985: 1,000 species per year
         4.) 2000: 20,000 species per year (estimated)
      b. Extinctions caused by man's many activities
   4. Impact of losses on man
      a. Potential food benefits for exploding human populations
      b. Potential medical benefits
      c. Health of existing ecosystems
   5. Reasons for wildlife losses
      a. Loss of habitat - the major reason
      b. Pollution of habitat
      c. Killing for food, sport, or profit
      d. The pet trade
      e. Predator and pest control
      f. Introduction of alien species
   6. Protecting wildlife
      a. International laws and treaties
      b. Wildlife refuges

c. Gene banks: zoos, botanical gardens, aquariums, etc.
d. Preserving ecosystems

7. Potential for reducing wildlife losses
8. Difficulties in attaining solutions

H. Critical considerations in regarding man as an ecological variable

1. Man's reproductive potential
2. Cultural limitations to human population control in discrete societies
   a. Social values
   b. Religious values
   c. Political values
   d. Economic values
3. Individual beliefs and values concerning rights and responsibilities
4. Man's unique abilities/adaptations
   a. Man's ability to simplify ecosystems, e.g., monobiotic agricultural ecosystems
   b. Man's ability to invent machines and processes for modifying natural ecosystems or maintaining artificial ones
   c. Man's ability to produce and use energy in the development and maintenance of man-made ecosystems, e.g., energy from coal-fired electrical generating plants

Outline Vignette: What Lies Ahead?

"If present trends continue, the world of 2000 will be more crowded, more polluted, less stable ecologically, and more vulnerable to disruption than the world we live in now. Serious stresses involving population, resources, and environment are clearly ahead. Despite greater material output, the world's people will be poorer in many ways than they are today."

The Global 2000 Report, 1980

YEAR TWO

ENVIRONMENTAL SCIENCE & ENVIRONMENTAL HEALTH

I. Man: His History of Resource Consumption (08%)

A. Early man: hunters and gatherers
   1. The age of the hunters and gatherers
   2. Survival demands of the hunters and gatherers
      a. Hunters and gatherers as experts in survival
      b. Food usage: exploitable food resources
      c. Mobility: the key to low levels of environmental impact.
   3. Other factors surrounding the hunters and gatherers
      a. Few material possessions
      b. Low levels of stress
      c. Low population levels
      d. Reasons for low population levels: high infant mortality, reduced conception due to breast feeding, 30 year life expectancy

B. Agricultural societies
   1. The domestication of plants and animals
   2. Small-scale farming
      a. Slash-and-burn cultivation
      b. Subsistence farming
         1.) Early practices
         2.) Current practices
   3. True agriculture of past societies
      a. Invention of the plow
      b. Animal power
      c. Irrigation
      d. Growing for consumption by others
   4. Agriculture-based urban societies
      a. Specialized agriculture
      b. Growing food for trade/profit
      c. Changing the earth's surface with larger tools
   5. Environmental impact of agriculture based urban societies
      a. Loss of forests
      b. Loss of grasslands
      c. Alteration of habitat for animal and plant species
      d. Soil erosion
      e. Waste disposal problems
      f. The evolution of the concept of "man against nature"

C. Industrial Societies
   1. The industrial revolution
      a. The steam engine and change
      b. The internal combustion engine and change
      c. Increased energy consumption
   2. Environmental impacts of industrial societies (##)
      a. Hazardous wastes of many kinds
      b. Pollution of air and water
      c. Increased environmental degradation
      d. Species extinction and its implications

D. The relationship of population to resource use, pollution, and environmental degradation. (##)
    1. Human population growth
        a. Population growth in developed nations
        b. Population growth in developing nations
    2. Population and resource use/abuse
        a. Cultural beliefs/values concerning resource consumption
        b. Use of renewable resources
        c. Use of nonrenewable resources
    3. Environmental degradation and resource consumption
        a. The "commons" concept
        b. The "tragedy of the commons" concept
        c. Population growth and its relation to the "commons" concept
        d. Risks associated with the "commons" concept
    4. Pollution and resource consumption
        a. Biodegradable pollutants
        b. Nonbiodegradable pollutants
        c. Exposure to pollutants
            1.) Movement of pollutants in the environment
            2.) Effects of pollutants on humans and other organisms
        d. Pollution control
            1.) In developed nations
            2.) In developing nations
    5. The interrelationships between population, resource use, technology, and cultural beliefs and values

Outline Vignette: Past Civilizations and Environmental Abuse

The great civilizations that flourished in the Middle East, North Africa, and the Mediterranean area between 3500 B.C. and 500 A.D. are noted for their many superb achievements in literature, art, science, and government . . . However, archeological evidence and historical records show that these agriculture-based urban societies prospered economically by degrading their land resource base so severely that they helped bring about their own downfall. . . . much of the land never recocovered and remains barren today.

G. Tyler Miller, Jr., 1988

II. Soils and Allied Problems (05%)

A. A definition of "soil"
    1. Inorganic components of soil
    2. Organic components of soil
B. Man's dependency on soils (##)
C. Soil formation
    1. Weathering
        a. Physical weathering
        b. Chemical weathering
    2. Categories of soils/characteristics
        a. Loams
        b. Sandy soils
        c. Clay soils
D. Soil Erosion (**)
    1. Natural erosion
        a. Wind erosion
        b. Water erosion

2. Erosion speeded up by man
3. Erosion around the world
    a. Location of serious erosion problems
    b. Factors associated with serious erosional problems
        1.) Cultivation of marginal lands
        2.) Poor cultivation techniques

E. The link between expanding human populations and soil erosion
1. The increased demand for agricultural products
2. Increased use of marginal agricultural land
3. Conversion of natural ecosystems (e.g., forests, wetlands) to farmland

F. Soil conservation strategies (##)
1. Minimum-tillage and no-till farming
2. Contour farming
3. Terracing
4. Strip cropping
5. Shelterbelts
6. Maintaining soil fertility
    a. Animal manures
    b. Green manures
    c. Compost
    d. Crop rotation

Outline Vignette: Soil Erosion: The Quiet Crisis

"Grave though the loss of topsoil may be, it is a quiet crisis, one that is not widely perceived. And unlike earthquakes, volcanic eruptions or other natural disasters, this human-made disaster is unfolding gradually. . . . On a third of the world's cropland, soil erosion far exceeds the natural rate of new soil formation of two to five tons per acre per year. At the core of this problem is the world's incessant demand for more food, which is driven by rising affluence and the annual addition of 86 million people. As the demand for food climbs, the world's farmers are beginning, in effect, to mine their soil. What was once a renewable resource is becoming a nonrenewable one."

World Watch, May - June 1988

III. Water and Allied Problems (10%)

A. The world's water supply
B. Renewing the water supply
1. The water cycle
2. The use of surface water
3. The use of ground water/aquifers

C. Problems with water resources (##)
1. Drought in arid and semiarid countries
    a. Population variables
    b. Poor land use variables
    c. Synergistic effects of population and land use variables - severe environmental degradation
2. Excess water and allied problems
    a. World-wide flooding
    b. Man's contribution to flood potential
        1.) Effect of deforestation
        2.) Effect of overgrazing
        3.) Effect of cultivating marginal land
        4.) Effect of urbanization

3. Irrigation problems
    a. Salinization of soils
    b. Water logging soils

D. Management strategies (##)
1. Dams and reservoirs
    a. Benefits
    b. Problems
2. Water diversion projects
    a. Benefits
    b. Problems
3. Using groundwater
    a. Benefits
    b. Problems
        1.) Aquifer/groundwater depletion
        2.) Subsidence
        3.) Saltwater intrusion
        4.) Groundwater pollution
4. Desalinization
    a. Benefits
    b. Problems
5. Other strategies/potential benefits and problems
    a. Towing icebergs
    b. Cloud seeding

E. Water conservation (##)
1. Importance of conservation strategies
2. Potential for conservation of water resources
3. Specific strategies for water conservation
    a. Wasting less water in the home
    b. Wasting less water in industry
    c. Reducing irrigation losses

IV. Food Production and Hunger (##) (10%)

A. The food that feeds the world
1. The plants that dominate food production by plants
2. The animals that provide most of the meat for those humans that can afford it

B. Food chain energy losses when meat is produced for human consumption

C. Characteristics of major world agricultural systems
1. Subsistence farming - labor intensive
2. Slash and burn agriculture - land intensive
3. Nomadic herding - land intensive
4. Industrialized agriculture - land, capital, and fossil fuel energy intensive

D. World food problems
1. Population growth vs food production
2. Nutritional problems
    a. Malnutrition
    b. Undernutrition
    c. Obesity
3. Food storage/distribution problems
4. Poverty
    a. Inability to buy food
    b. Inability to purchase land to grow food

5. Environmental effects of producing more food
    a. Overfishing
    b. Overgrazing
    c. Soil erosion
    d. Salinization/waterlogging
    e. Waterborne diseases
    f. Deforestation
    g. Extinct and endangered species
    h. Pollution
    i. Loss of genetic diversity
    j. Climatic changes
    k. Health risks from food additives

E. The "green revolution"
    1. Developing new hybrids
    2. The potential for the "green revolution"
    3. Limitations of the "green revolution"
        a. The need for increased use of fertilizer and water
        b. Increased soil infertility where crop rotation is reduced
        c. The limits to increasing yields (diminishing returns)
        d. Loss of genetic diversity in food producing plant varieties

F. The use/cultivation of unconventional food plants
    1. Plants with potential
        a. The winged bean
        b. Cocoyam
        c. Quinoa
        d. Others
    2. Cultural biases against new foods

G. Increasing utilization of fish
    1. Characteristics of the world fishery
    2. Overfishing
    3. Fish farming and aquaculture
    4. Hopes for increasing fishery production
        a. Regulating overfishing
        b. Turning to new/unconventional species
        c. Constraints to increasing yields

H. Sustainable agriculture
    1. Learning self-sufficiency in food production
    2. China as a world leader in sustainable agriculture
    3. Potential benefits of sustainable agriculture in the developed nations
    4. Reducing the enormous waste of food in the developed nations

I. Responsibilities of the individual for reducing world hunger

Outline Vignette: The Growth of Oil-Based Agriculture

"From the beginning of agriculture until roughly 1950, growth in food output came almost entirely from expanding the area under cultivation. From that point on, farmers had to increase the productivity of the land. To do so, they turned to energy-intensive farming practices, boosting yields by applying fertilizer and water to their fields.

Intensive cultivation came to be synonomous with the intensive use of oil. Since 1950, agriculture's use of fossil fuels has multiplied sixfold. Between 1950 and 1985, the farm tractor fleet quadrupled, world irrigated area tripled, and fertilizer use increased ninefold.

World Watch, March - April 1988

V. Forest Resources (05%)

A. Importance of forest resources (##)
   1. Commercial Importance
   2. Ecological importance
   3. Climate control
   4. Pollution control

B. Short term vs long term benefits of forests, e.g., economic values vs ecological values (##)

C. The world's forests
   1. The seven nations in which two-thirds of the world's forests are found
      a. USSR
      b. Brazil
      c. Canada
      d. USA
      e. Zaire
      f. China
      g. Indonesia
   2. Loss of forests since the Agricultural Revolution - about one-third of the world's forests
   3. Current loss of forests - about 1% per year (##)
      a. Losses due to firewood crises in emerging nations
      b. Tropical deforestation
         1.) Clearing land to grow food
         2.) Cutting and gathering firewood
         3.) Commercial logging
         4.) Ranchers clearing forests to grow beef for export
   4. Serious issues associated with forest management (##)

Outline Vignette: The Plight of the Amazon Rain Forest

"Amazonia, the world's largest and one of its oldest rain forests, is facing perilous development pressures. At least a million trees are felled every twenty-four hours, and over one tenth of the forest has already disappeared. A 1975 satellite photograph indicated 62,000 square miles (161, 000 square kilometers) of forest had been leveled in a single year. At that rate of deforestation, the Amazon rain forest could virtually disappear by the year 2000."

The Cousteau Almanac, 1981

VI. Plant and Animal Resources (##) (10%)

A. Arguments for preserving plant and animal species
   1. Economic and human needs
      a. Wildlife and economic benefits
         1.) Sport fishing
         2.) Sport hunting
      b. Direct economic benefits
         1.) Food/spices/cooking oils
         2.) Medicines
         3.) Soap/scents
         4.) Oils/waxes
         5.) Insecticides

6.) Fuel
7.) Fiber and paper
8.) Others

c. Pollination as an essential activity
d. Medicines
1.) A vast array of medicines in use today
2.) Potential life saving medicines for the future
e. Aesthetic/recreational importance
f. Ecological importance
1.) Maintaining the health of the world's ecosystems
2.) Recycling nutrients
3.) Pest and disease control
4.) Storehouse of genetic material
g. Ethical importance
1.) The inherent right of an organism to survive
2.) Man's inability to understand his relationship with nature

B. Extinction/endangered species
1. Natural extinction and rates
2. Man-caused extinction and rates
a. 1975: 100 species per year
b. 1985: 1000 species per year
3. The role of tropical rainforest destruction in extinction
4. Endangered species
a. Loss of habitat
b. Commercial hunting
c. Predator and pest control
d. Pollution
e. The pet trade
f. Abuse by selected zoos
g. Introduction of alien species

C. Protecting species from extinction
1. International law and treaties
2. Wildlife refuges
3. The role of zoos and related agencies
4. Gene banks
5. Preservation of ecosystems

D. The individual's responsibility for preserving plants and animals

Outline Vignette: An Exotic Snake and Ecological Disaster on Guam

An introduced, alien species, the brown tree snake is threatening to wipe out the native birds of Guam. "This tale of ecological calamity . . . began soon after the end of World War II. . . . Eons of isolation had produced five species or subspecies [of birds] . . . found nowhere else on Earth. . . . in the absence of major predators, many of the birds were defenseless and unwary. . . . By the late 1960's, most of the forest birds had disappeared from the southern half of the island . . . ."

National Wildlife, Aug.-Sept. 1988

VII. Air Pollution (08%)

A. Sources of air pollution (##)
1. Auto and truck transportation
2. Coal and oil burning power plants

3. Smelters, refineries, pulp and paper mills

B. Major pollutants
   1. Particulate matter
   2. Sulfur dioxide
   3. Carbon monoxide
   4. Nitrogen dioxide
   5. Ozone
   6. Lead
   7. Hydrocarbons
   8. Radon

C. Impact of air pollution on human health (##)
   1. Increased death rate
   2. Chronic respiratory disease
   3. Acute respiratory disease
   4. Cancer
   5. Heart disease

D. Acid precipitation ("Acid Rain")
   1. Acid rain defined
   2. Sources of acid rain and transportation of acid rain pollutants
   3. Extent of the problem worldwide
   4. Effect on lakes/forests
   5. Reduction of crop yields
   6. Deterioration of buildings and statuary
   7. International dispute over acid rain
   8. Remedies for acid rain

E. Indoor air pollution
   1. Radon gas
   2. Products of combustion
      a. Carbon monoxide
      b. Nitrogen oxides
      c. Particulates (smoke)

F. Stratospheric ozone depletion from the use of chlorofluorocarbons (CFC's) - a unique and dangerous form of air pollution

Outline Vignette: Leading Producers of CFC's Promise Reform.

Major policy shifts are being taken by leading U.S. producers and users of chlorofluorocarbons (CFC's), in the wake of new evidence that ozone depletion is an even worse problem than was thought. The Du Pont company, the world's leading CFC producer, announced in March [1988] that it will phase out all production of fully halogenated CFC's, the chemicals most responsible for destroying stratospheric ozone. Two weeks later, the Foodservice and Packaging Institute, which represents foam food packaging manufacturers, committed itself to phase out the most harmful CFC's in less than 9 months.

EDF Letter, June 1988

VIII. Water Pollution (##) (10%)

A. Sources of freshwater surface pollution
   1. Point sources
   2. Nonpoint sources
      a. Soil erosion/sedimentation
      b. Construction Activities

c. Animal feedlot runoff
d. Pesticides/fertilizer runoff
e. Street/parking lot runoff
f. Acid mine deposits (runoff)
g. Acid rain deposition

3. Thermal pollution of rivers and lakes from power plants

B. Human disease traced to water pollution

1. Organismic diseases
   a. From bacteria, e.g., typhoid fever, cholera. enteritis
   b. From viruses, e.g., hepatitis, polio
   c. From protozoans, e.g., amoebic dysentery
   d. From parasites, e.g., schistosomiasis
2. Inorganic substances
   a. From arsenic, e.g., kidney, liver, nervous system damage
   b. From cadmium, e.g., kidney damage, high blood pressure
   c. From lead, e.g., mental retardation, anemia, birth defects
   d. From mercury, e.g., nervous system and kidney damage
3. Synthetic organic substances
   a. Benzene, e.g., chromosome damage, leukemia
   b. Carbon tetrachloride, e.g., cancer, liver and kidney damage
   c. Dioxin, e.g., cancer, genetic mutations
   d. PCB's, e.g., liver, kidney, pulmonary damage
   e. Vinyl chloride, e.g., liver, kidney and lung damage; cancer

C. Oceanic pollution

1. Threats to the oceans' ecosystems
2. Ocean dumping
3. Ocean oil pollution

D. Groundwater pollution

1. Groundwater as a vital source of drinking water
2. Sources of groundwater contamination
   a. Point sources
   b. Nonpoint sources
3. Difficulty of detection and correction of groundwater pollution
4. The need for prevention of groundwater pollution

E. Wastewater treatment: a critical need

1. Proper sewage treatment
   a. Septic tanks
   b. The sewage lagoon
   c. Alternative sewage treatment for the rural home owner
   d. Urban sewage treatment
      1.) Primary treatment
      2.) Secondary treatment
      3.) Tertiary treatment
   e. Disposal of sewage effluent and sludge
   f. Alternatives to large-scale treatment
2. The individual's role
   a. The safe disposal of household toxic chemicals
   b. Recycling waste oil
   c. The use of low-phosphate detergents
   d. Limited use of pesticides, bleaches, inorganic fertilizers
   e. Using less water

IX. Noise Pollution (05%)

A. Sources and levels of noise in the environment
B. Effect of noise on the human organism
    1. Hearing loss
    2. Stress and related health effects
    3. Effect on unborn children
    4. Effect on learning and work performance
    5. Sleep disruption
    6. Noise and safety
C. Noise control
    1. Municipal noise control
    2. Nations' efforts at noise control
    3. Individual opportunities for noise control
        a. Keeping radio/stereo volume low
        b. Wearing ear protection when using noisy equipment
        c. Using sound absorbing materials in the home
        d. Supporting local ordinances designed to control noise

X. Solid Waste Disposal (##) (10%)

A. Solid waste defined
B. Sources of solid waste in the USA
    1. Agriculture - Appx. 50%
    2. Mining - Appx. 38%
    3. Industrial - Appx. 9 %
    4. Municipal (individuals) - Appx. 3-5%
C. Sources of municipal waste
    1. Paper
    2. Food
    3. Yard wastes (leaves, etc.)
    4. Glass
    5. Metals
    6. Wood
    7. Plastics
    8. Rubber/leather
    9. Textiles
D. Solid waste produced by affluent nations compared to nonaffluent nations
E. Methods of municipal waste disposal
    1. Water dumping
    2. Open dumping - littering
    3. Sanitary landfills
    4. Incineration
    5. Composting
    6. Resource recovery
        a. Resource recovery plants
        b. Source separation
            1.) Homes
            2.) Businesses

F. Source reduction of wastes
    1. Marketing reusable consumer goods
    2. Elimination of excessive packaging
    3. Designing appliances/autos to last longer
    4. Beverage container deposits
G. Issues surrounding solid waste management
H. The individual's obligation/opportunity to help resolve solid waste problems

Outline Vignette: The USA Slow to Accept Reforms in Ecologically-Sound Solid Waste Management

" . . . 'It's not so much that waste reduction is not happening [in the United States], but that it is not happening nearly to the extent it could or should be.'

Clearly, as the country's population grows, getting rid of wastes will beome a more urgent concern. The question is: are we willing to make the difficult decisions that require balancing present-day realities with a vision of an ideal future?"

National Wildlife, Aug. - Sept. 1988

[Note: An abbreviated case study on solid waste management appears in the Appendices of this document. It is intended to be used as is or as a model for the development of other case studies for use in Year II.]

XI. Hazardous Waste (07%)

A. Hazardous waste defined
B. Sources of hazardous waste
    1. Chemical industries
    2. Machinery and transportation equipment industries
    3. Motor freight transport
    4. Petroleum refining
    5. Metals production and fabricating industries
    6. Electrical machinery industries
    7. Electric, gas, and sanitary service industries
    8. Household hazardous wastes
C. Hazardous waste disposal in the past
D. Hazardous waste disposal today - alternatives
    1. Secure chemical landfills
    2. Physical, chemical, and biological treatment
    3. Deep well injection
    4. Incineration
    5. Recycling
    6. "Midnight dumping"
E. Issues surrounding hazardous waste disposal
F. The individual's opportunity to help resolve hazardous waste problems (##)
    1. Being knowledgeable enough to make rational decisions about proposed hazardous waste facilities
    2. Insisting that existing laws be enforced
    3. Using less hazardous household chemicals
    4. Cautiously disposing of household hazardous waste

Outline Vignette: Controlling Pesticides in Developing Nations

Developing countries are expected to continue increasing not only the absolute quantities of pesticides they use but their proportion of global consumption. Dangerous misuses of pesticides also promise to continue, thus making it clear that agencies both inside and outside these countries need to strengthen their efforts to reform current practices.

In addition to human health effects, pesticide misuse results in substantial economic and environmental losses - including decreased labor productivity, increased health-care costs, more expensive water treatment, and contaminated natural resources. Overuse or improper disposal can damage commercially important industries . . .

Conservation Foundation Letter - No. 2, 1988

XII. Human Population Growth and Control (##) (12%)

A. No population can sustain limitless growth
B. A complicated set of variables associated with human population dynamics
    1. Birth rates and death rates
    2. Total fertility rates
    3. Life expectancy
    4. Infant mortality
    5. Annual population change rate
    6. Doubling time
    7. Migration patterns
C. Age structure
    1. Age structure and population momentum
    2. Making population projections from age structure diagrams
D. Issues associated with world's population size and growth
    1. Arguments against world population growth
    2. Arguments in favor of world population growth
E. Economic development and population changes
    1. Population and economic data from developed nations
    2. Population and economic data from developing nations
    3. The potential for economic development in developing nations
    4. Threats to economic development in developing nations
F. Advantages of family planning combined with economic development
    1. Educational services
    2. Clinical services
    3. Results of family planning in nations where instituted, e.g., India; China
    4. Costs of family planning services
G. Immigration and population dynamics
    1. Legal immigration
    2. Illegal immigration
    3. Consequences of immigration
    4. Restrictions to immigration
H. Birth control and population dynamics
    1. Preventing pregnancies
    2. Terminating pregnancies
    3. Future possibilities for birth control
I. Major issues associated with global/national population growth and control

YEAR THREE

ISSUE INVESTIGATION AND CITIZENSHIP ACTION TRAINING

I. Environmental Problem Solving (##) (15%)

A. Human-environment interactions
B. Quality of life vs quality of the environment
C. Environmental problems and issues
    1. Characteristics of environmental problems
    2. Characteristics of environmental issues
        a. The role of human beliefs in issues
        b. The role of human values in issues
        c. The relationship between beliefs and values
D. Issue analysis - a way to understand the anatomy of issues
    1. Identifying the issue
    2. Identifying the "players" and their positions
    3. Identifying players' beliefs regarding the issue
    4. Analyzing belief statements for underlying values
E. Presenting examples (models) of issues which have been analyzed
F. Applying issue analysis skills to discrete issues

Outline Vignette: What Kind of People Are We?

"The environmental crisis is an outward manifestation of a crisis of mind and spirit. There could be no greater misconception of its meaning than to believe it to be concerned only with endangered wildlife, human-made ugliness, and pollution. These are part of it, but more importantly, the crisis is concerned with the kind of creatures we are and what we must become in order to survive."

Lynton K. Caldwell

II. Identifying Issues and Preparing Research Questions (##) (10%)

A. Identifying environmental issues
    1. Local issues
    2. Regional issues
    3. National issues
    4. International issues
B. Identifying variables associated with environmental issues
    1. Variables associated with human environmental behavior
    2. Variables associated with human beliefs and values
    3. Variables associated with socio-cultural implications
    4. Variables associated with ecological implications
C. Formulating (writing) research questions for issue investigation
    1. Determining (inferring) cause and effect relationships between variables
    2. Rules for writing research questions
        a. Derive questions from environmental issues
        b. Ask questions which are important in an environmental and social sense
        c. Avoid questions that ask for "yes" and "no" responses
        d. Specify variables to be measured
        e. Specify the relationship between variables (when possible)

f. Indicate a population or area to be investigated
3. Practice in writing research questions
4. Evaluating written research questions using rules as criteria (see No. 2, above)

III. Using Secondary Sources for Obtaining Issue Information (##) (15%)

A. Secondary sources of issue-related information
1. Using library sources
a. Skill No. 1: Using the Card Catalog
b. Skill No. 2: Using the Readers' Guide
c. Skill No. 3: Using cross indexing
2. Periodicals and newsletters with an environmental focus
3. Environmental organizations
4. Governmental environmental agencies
5. Using local resource people for gaining information
6. Writing letters for information
a. Choosing the appropriate source
b. Specifying needed (desired) information
c. Using correct style
B. Processing information from secondary sources
1. Obtaining information from all sides of the issue
2. Identifying bias in secondary source information
3. Summarizing information from secondary sources
C. Reporting secondary source information
1. Report form and style
2. Citations of references
3. Bibliography

IV. Using Primary Sources for Obtaining Issue Information (##) (15%)

A. Surveys, questionnaires, and opinionnaires (survey instruments)
1. Definitions of survey instruments
2. Rules for producing survey instruments
3. Models of survey instruments
B. The interview as an important research technique
C. Selecting the appropriate population to be sampled
D. Basic procedures to be used in sampling populations
E. Data collection strategies
F. Developing and using survey instruments/interviews

V. Interpreting Data from Environmental Issue Investigations (##) (10%)

A. Organizing data in data tables
B. Communicating data by graphing
1. Bar graphs (histograms)
2. Coordinate (line) graphs
3. Pie graphs

C. Interpreting data - skill development sequence
    1. Making conclusions
    2. Making inferences
    3. Making recommendations
D. Applying data interpretation skills to issue-related data sets

VI. The Independent Investigation of a Student-Selected Environmental Issue (##) (20%)

A. Selecting an issue for investigation
B. Formulating research questions to guide the investigation
C. Collecting secondary information
    1. Library search
    2. Contacting appropriate agencies/organizations
    3. Letters for information
D. Collecting primary information
    1. Develop appropriate survey instruments
    2. Identify the appropriate population for sampling
    3. Develop appropriate sampling procedures
    4. Administer the survey instrument
E. Issue analysis/data interpretation
    1. Organize the collected data into tables/graphs/prose
    2. Analyze information for "players", beliefs, and values
    3. Interpret the findings (data-based conclusions, inferences, and recommendations)
F. Communication of investigation and results
    1. Produce written issue investigation reports
    2. Present issue investigation to classmates and other appropriate groups

VII. Issue Resolution: Skills and Application (##) (15%)

A. Citizenship responses to issues and their effects
    1. Environmentally negative responses
    2. Environmentally positive responses
B. Principles of environmental (citizenship) action
    1. The responsibility to be knowledgeable about issues
    2. The responsibility to be skilled in issue resolution
    3. The responsibility of knowing the effect of actions
    4. The responsibility to consider potential negative and positive effects prior to taking an action
C. The methods (modes) of citizenship action
    1. Persuasion (persuasive action)
    2. Consumerism (consumer action)
    3. Political action
    4. Legal action
    5. Ecomanagement (some form of physical action)
D. Effectiveness of individual vs group action
E. Guidelines for decision-making: criteria to be considered
    1. Sufficient evidence to warrant action on the issue
    2. Alternative actions which are available
    3. Relative effectiveness of action(s)

4. Legal consequences of action
5. Social consequences of action
6. Economic consequences of action
7. Consideration of personal values in relation to the action
8. Consideration of beliefs and values of others involved in the issue
9. An understanding of the procedures necessary to take action
10. Ability to complete the action
11. Courage to take the action
12. Time needed to complete the action
13. Other resources needed to make the action effective
14. Ecological consequences of the action

F. Applying issue resolution skills
1. Producing a plan of action
2. Evaluating the plan of action (using criteria in E, above)
3. Carrying out the plan of action (optional)
4. Evaluating the effectiveness of action(s) taken

Outline Vignette: Man Confronting Environmental Issues

"The answers to the perplexing issues associated with the environment lie not so much in an advanced technology as they do in a human population that, at long last, realizes that solutions exist in human beliefs and values and in the ability of each and every person to confront the issues in logical and productive ways."

H. R. Hungerford, et al., 1988

Where can important environmental content be infused? Let us look at just a few examples and anecdotes. For example, in a middle school in New Jersey (USA) there was an interest in implementing environmental issue instruction using a team-teaching approach (infusing issue instruction into science, language arts, and social studies). The language arts teacher was skeptical - unsure whether this infusion would interfere with his program of skill development in the language arts. Even so, he agreed to study the components of issue investigation and respond to the challenge a day later. He came back to the group the next day and stated that the language processes involved in issue instruction would meet over fifty percent (50%) of his course objectives. The social studies teacher, concerned that her students had an opportunity to study social problems, had no problem seeing the relationships that existed between environmental issues and social issues since all environmental issues have a strong social dimension. Of course, the science content was obvious.

In another instance, where issue instruction was implemented in the middle school, the school librarian worked with the science teacher, assisting her with instruction in certain language skills and providing environmentally-related secondary resources for the students. The librarian reported that she was astounded to find that the issue-focused students' research skills were much better than the skills of other students. She was also impressed with the seriousness with which those students approached their library research. The students became so skilled in using secondary sources from the library that they didn't need to be re-taught library skills in subsequent years. One would not necessarily expect this kind of an outcome from an environmental program but this is exactly what happened.

The writers can cite numerous examples of two teachers working cooperatively - typically science teachers working with social studies teachers or language arts teachers to meet the needs of learners. In all instances, some form of infusion was involved. Usually, the science teacher prompted the team-teaching and the infusion but not always. Sometimes, the social studies teacher led the way. It matters not! Infusion took place and cooperative teaching occurred.

In other instances, teachers of home economics and agriculture have requested training for infusing environmental content into their subject matter areas. Many environmentally-related issues are suitable for home economics instruction, e.g., those having to do with energy consumption and conservation, those having to do with the relationships between human reproduction and family living, issues related to environmentally-sound consumer behavior, issues related to home sanitation and disease, issues associated with toxic chemicals and food production, etc. In agriculture, numerous environmental issues are available for infusion, e.g., issues associated with food production, soil erosion, desertification, herbicides, insecticides, livestock grazing, loss of agland due to construction, etc. Courses such as home economics and agriculture can play an important part in an overall infusion of environmental education into the middle school curriculum.

Pros and Cons of Infusion

With respect to the environmental scope and sequence presented in Chapter III, the reader is reminded, once again, that this scope and sequence can be dealt with as a separate subject. Of course, there are some substantial advantages for dealing with it in this manner. Among them would be respecting the integrity of both the scope and sequence of the programme. Fewer teachers would have to be trained in the content, skills, and methodology associated with the programme. The need for grappling with the problems associated with infusion would be lessened. However, there are also some disadvantages. One marked disadvantage lies in not being able to use other content areas as vehicles for promoting the knowledge and skills in this scope and sequence. Language arts, social studies, science, home economics,health, agriculture and other courses are ideal vehicles for infus-

CHAPTER IV

INFUSING ENVIRONMENTAL CONTENT AND SKILLS INTO THE MIDDLE SCHOOL CURRICULUM

Introduction

Chapter III of this document lays out a three year scope and sequence for environmental education in the middle school. It is important to note that this scope and sequence can be delivered as a single subject or it can be infused into existing courses within the middle school curriculum. The scope and sequence simply portrays the scope of a recommended environmental education programme and shows a defensible sequence which would make conceptual (and skill development sense) to instructors and learners combined.

Infusion is a relatively simple process to understand but a rather complex process to accomplish. Simply stated, infusion refers to the integration of content and skills into existing courses in a manner as to focus on that content (and/or skills) without jeopardizing the integrity of the courses themselves. In the case of environmental education, the educator carefully analyzes existing courses for places where environmental content and associated skills could be incorporated.

A key component in the infusion process rests with the faculty of the school attempting to incorporate an infused environmental education programme. Any comprehensive infusion strategy demands a great deal of cooperation from staff members who are going to be responsible for the infused programme. The faculty must be sympathetic toward the infusion and the members of that faculty must be willing to work cooperatively to build a plan for infusion and see that that plan is carried out. A major ingredient of that "plan" must be to respect the integrity of the scope and sequence in a manner that guarantees that instruction will proceed logically across content areas. Sometimes this can be accomplished by teachers working independently of others but often it necessitates team teaching with instructors from two or more content areas working cooperatively to deliver well-thought out instruction.

If time and other resources permit, an "infusion institute" can be designed which would permit faculty members to be trained in infusion techniques and provide time for them to plan for the infusion of environmental content and skills. In addition, such an institute would allow participants to identify barriers to infusion and develop strategies for removing these barriers. This strategy will often counteract a common behavior which consists of looking for problems more diligently than looking for solutions. Human nature being what it is, excuses are far easier to come by than solutions to problems.

Some Insights Into Infusion

Over the past several years, the authors of this document have spent a good part of their professional lives training faculty members in environmental content and issue investigation strategies. One of the things to come out of this training is the knowledge that environmental content and skills can often be integrated into existing courses without interfering with the content and skills desired by involved faculty members.

ing environmental content without threatening the integrity of those courses. Also, one must remember the very important educational concept of reinforcement. If the environmental programme were taught effectively across content areas at the middle school level, the opportunity to observe changes in learner behavior outside of school would be increased dramatically.

Inspecting the Scope and Sequence for Infusion Possibilities

In an effort to provide some assistance to schools desiring to infuse environmental content across the curriculum, the writers have constructed a series of three (3) tables which provide insight into the potential for infusion. It should be made clear, however, that these tables show possibilities only! Educational needs and opportunities will vary from school to school and a given faculty may choose to infuse quite differently from what is shown in these tables.

Infusion Possibilities for Year One
Ecological Foundations and Man as an Ecological Factor

Outline Topic	SC	HE	SS	MA	LA	HO	AG
I. What is Ecology? What do Ecologists Do?							
A. Defining "ecology"	X						
B. The role of ecologists	X		X				X
II. Individuals, Populations, and Levels of Organization in Ecology	X						
III. The "Ecosystem Concept" Developed							
A. Importance of the concept	X						
B. Local/regional ecosystems	X						
C. Components of ecosystems	X						X
D. Ecological niches	X						X
E. Competition . . .	X						X
F. Tolerance ranges . . .	X						X
IV. Energy and Ecosystems							
A. The need for energy . . .	X					X	X
B. The sun as the source . . .	X					X	X
C. Green plants as the basis . . .	X						X
D. Energy losses . . .	X					X	X
E. Net primary productivity . . .	X						X
V. Ecological Succession . . .							
A. Succession as a natural phenomenon	X						X
B. Succession as an orderly phenomenon	X						
C. Major categories . . .	X						X
D. A comparison of stages	X						
VI. Populations and Their Dynamics	X						X

Key: SC = Science; HE = Health; SS = Social Studies; MA = Math; LA = Language Arts; HO = Home Economics; AG = Agriculture

Outline Topic	SC	HE	SS	MA	LA	HO	AG
Key: SC = Science; HE = Health; SS = Social Studies; MA = Math; LA = Language Arts; HO = Home Economics; AG = Agriculture							
VII. Man As An Ecological Factor							
A. Man as a powerful variable	X		X				X
B. Man as an eruptive population	X		X	X			
C. Consequences of eruptive human populations	X		X			X	X
D. Man and the world's soils			X				X
E. Man and the world's forests	X		X				X
F. Man and the world's wetlands	X		X				X
G. Man and the world's wildlife	X		X	X			
H. Critical considerations . . .	X		X				X

Infusion Possibilities for Year Two
Environmental Science & Environmental Health

Outline Topic	SC	HE	SS	MA	LA	HO	AG
Key: SC = Science; HE = Health; SS = Social Studies; MA = Math; LA = Language Arts; HO = Home Economics; AG = Agriculture							
I. Man: His History of Resource Consumption							
A. Early Man: hunters/gatherers			X				
B. Agricultural societies	X		X				X
C. Industrial societies	X		X				
D. Relation of population . . .	X	X	X	X		X	X
II. Soils and Allied Problems							
A. A definition . . .	X						X
B. Man's dependency . . .	X						X
C. Soil formation	X						X
D. Soil erosion	X						X
E. The link between human population/soil erosion			X				X
F. Soil conservation strategies							X
III. Water and Allied Problems							
A. The world's water supply	X		X				
B. Renewing the water supply	X		X				
C. Problems with water resources	X		X				X
D. Management strategies	X		X				X
E. Water conservation	X		X			X	X
IV. Food Production and Hunger							
A. The food that feeds the world	X		X			X	X
B. Food chain energy losses . . .	X					X	X
C. Characteristics of agricultural systems	X		X				X

Outline Topic	SC	HE	SS	MA	LA	HO	AG
Key: SC = Science; HE = Health; SS = Social Studies; MA = Math; LA = Language Arts; HO = Home Economics; AG = Agriculture							
D. World food problems	X	X	X			X	X
E. The green revolution	X						X
F. . . . unconventional food plants	X					X	X
G. Increasing utilization of fish	X					X	X
H. Sustainable agriculture			X				X
I. Responsibilities of the individual . . .			X				X
V. Forest Resources							
A. Importance . . .	X		X				
B. Short term vs long term benefits. . .			X				
C. The world's forests			X				X
VI. Air Pollution							
A. Sources of air pollution	X		X				
B. Major pollutants	X	X					
C. Impact on human health	X	X					
D. Acid precipitation	X	X					X
E. Indoor air pollution	X	X				X	
F. Ozone depletion	X	X				X	
VIII. Water Pollution							
A. Sources of surface pollution	X						X
B. Human diseases traced to . . .		X				X	
C. Oceanic pollution		X					
D. Ground water pollution	X	X				X	X
E. Waste water treatment	X	X				X	
IX. Noise Pollution							
A. Sources and levels	X						
B. Effect of noise on humans	X	X				X	
C. Noise control	X	X	X			X	
X. Solid Waste Disposal							
A. Solid waste defined		X				X	
B. Sources of solid waste		X				X	X
C. Sources of municipal waste		X				X	
D. Affluent/nonaffluent nations			X	X			
E. Methods of municipal waste disposal		X				X	
F. Source reduction of wastes	X		X			X	X
G. Issues surrounding solid waste management	X	X	X			X	X
H. The individual . . .			X			X	X
XI. Hazardous Waste							
A. Hazardous waste defined	X	X				X	X
B. Sources of hazardous waste	X					X	X
C. Hazardous waste disposal in the past	X					X	X
D. Hazardous waste disposal today	X					X	X

Outline Topic	SC	HE	SS	MA	LA	HO	AG
Key: SC = Science; HE = Health; SS = Social Studies; MA = Math; LA = Language Arts; HO = Home Economics; AG = Agriculture							
E. Issues surrounding hazardous waste disposal	X		X			X	X
F. The individual . . .			X			X	X
XII. Human Population Growth and Control							
A. No population can sustain limitless growth	X			X		X	
B. Human population dynamics	X		X	X		X	
C. Age structure	X		X	X			
D. Issues associated with . . .	X		X			X	X
E. Economic development and population changes			X	X		X	
F. Advantages of family planning combined with economic development		X	X			X	
G. Immigration and population dynamics			X				
H. Birth control and population dynamics		X				X	
I. Major issues . . .	X	X	X			X	

Infusion Possibilities for Year Three
Issue Investigation and Citizenship Action Training

Outline Topic	SC	HE	SS	MA	LA	HO	AG
Key: SC = Science; HE = Health; SS = Social Studies; MA = Math; LA = Language Arts; HO = Home Economics; AG = Agriculture							
I. Environmental Problems Solving							
A. Human-environment interactions	X		X				
B. Quality of life vs quality of the environment	X	X	X			X	X
C. Environmental problems and issues	X	X	X			X	X
D. Issue analysis	X	X	X			X	X
E. Examples of analyzed issues	X	X	X			X	X
F. Applying issue analysis skills	X	X	X			X	X
II. Identifying Issues and Preparing Research Questions							
A. Identifying environ. issues	X	X	X			X	X
B. Identifying variables assoc. with environmental issues	X		X				

Outline Topic	SC	HE	SS	MA	LA	HO	AG
Key: SC = Science; HE = Health; SS = Social Studies; MA = Math; LA = Language Arts; HO = Home Economics; AG = Agriculture							
C. Writing research questions	X		X		X		
III. Using Secondary Sources							
A. Secondary sources of issue-related information					X		
B. Processing information from secondary sources			X		X		
C. Reporting secondary source information					X		
IV. Using Primary Sources							
A. Surveys, questionnaires, and opinionnaires	X		X		X		
B. The interview					X		
C. Selecting the population	X		X	X			
D. Procedures of sampling	X		X	X			
E. Data collection strategies	X		X				
F. Developing and using instruments/interviews	X	X	X		X	X	X
V. Interpreting Data from Environmental Issue Investigations							
A. Organizing data in data tables	X		X	X			
B. Communicating data by graphing	X		X	X			
C. Interpreting data	X		X		X		
D. Applying data interpreting skills to issue-related data sets	X	X	X			X	X
VI. The Independent Investigation of a Student-Selected Environmental Issue							
A. Selecting an issue . . .	X	X	X		X	X	X
B. Writing research questions	X	X	X		X	X	X
C. Collecting secondary information			X		X		
D. Collecting primary information	X	X	X	X	X	X	X
E. Issue analysis/data interpretation	X		X	X	X		
F. Communication of results					X		
VII. Issue Resolution: Skills and Application							
A. Citizenship responses to issues and their effects	X	X	X			X	X
B. Principles of citizenship action			X				
C. Methods of citizenship action			X			X	X
D. Individual vs Group Action		X	X			X	X
E. Guidelines for decision-making	X	X	X			X	X
F. Applying issue resolution skills	X	X	X		X	X	X

Appendix I

The "Ecosystem": A Basic Concept in Ecology

A Sample Ecology Chapter for Year One

Reference: Chapter III

Year I, Part III, A, B, C, D, E

CHAPTER III *

THE "ECOSYSTEM": A BASIC CONCEPT IN ECOLOGY

NOTE: This chapter serves as a model for middle school curriculum developers in the field of environmental education (see Year One of "The Three Year Curriculum: A Detailed Outline", Chapter III). It is, however, an abbreviated model, i.e., it does not contain all of the content found in the outline. Space does not permit the full development of this chapter. Even so, it does include a large portion of the learner objectives, visuals, prose, and activities one would find in such a document developed for middle school students.

LEARNER OBJECTIVES FOR THIS CHAPTER

After completing Chapter III, the student will be expected to be able to . . .

1. . . . define the term "ecosystem" and provide a minimum of five examples. For each example the student is expected to be able to defend its selection as an example.

2. . . . explain why the ecosystem concept is so very important in the science of ecology.

3. . . . define the term "ecological community".

4. . . . differentiate between an "ecological community" and an "ecosystem".

5. . . . identify the two major categories of biotic variables in an ecosystem: (a) food producers and, (b) consumers.

6. . . . identify a minimum of five abiotic variables found in ecosystems. For each, be able to explain how that variable impacts on the character or development of the ecosystem.

7. . . . explain how biotic variables can influence abiotic variables in an ecosystem.

8. . . . explain in detail the following statement: "Energy drives ecosystems".

9. . . . define the term "habitat". Further, explain why habitat is crucial to the survival of a species in an ecosystem (and provide examples of organisms that are very dependent on habitat for survival).

10. . . . define the term "niche". Further, be able to distinguish between "habitat" and "niche".

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* This ecology chapter model is from curriculum materials under development by the authors. It is presented here courtesy of the authors and may be reprinted in part or in its entirety for educational purposes.

11. . . . explain why a species' niche is much more than its food-related activities in an ecosystem.

12. . . . define the term "specialized niche" and provide examples of organisms with specialized niches. Further, the student will be able to explain why these examples are good ones.

13. . . . define the term "generalized niche" and provide examples of organisms with generalized niches. Further, the student will be able to explain why these examples are good ones.

14. . . . explain why an organism with a "specialized niche" may be very susceptible to changes in the ecosystem.

15. . . . diagram or describe the "layering concept" associated with many ecosystems and provide examples. Further, explain why the layering concept is useful in interpreting ecosystems.

16. . . . explain why organisms are interrelated in the ecosystem (and provide valid examples of this interrelatedness).

17. . . . explain why organisms are involved in "competition" within ecosystems and provide valid examples. Also, distinguish between the terms "intraspecific competition" and "interspecific competition".

18. . . . explain the relation between "tolerance ranges" and "limiting factors" in ecosystems.

19. . . . explain what is meant by the "optimum range" of an organism for a factor. Differentiate between "range of stress" and "optimum range".

20. . . . provide examples of factors and organisms as well as general "optimum ranges" for those factors and organisms.

21. . . . enter a local ecosystem and describe it and its components in terms of the concepts learned in this chapter. Further, be able to explain the interrelatedness of the variables observed in that ecosystem.

A LESSON FROM THE PAST

Part I

It was an unusually hot day for April on the Great Plains of North America. The year was 1869. It had rained hard the night before and the humidity was high. The two men in buckskins sweated heavily as they made their way to the top of the hill overlooking a broad grassy valley. The big bearded man with the broad-brimmed hat mumbled softly as he caught his foot on a piece of granite rock hidden by green grass plants nearly a foot high. Although winter was still a clear memory, the big man's face was well tanned from many weeks in the sun on the plains of the Oklahoma Territory. His buckskins were

cracked and filthy. He needed new ones. And, neither he nor his skinner smelled very good. It had been a long time since their last bath.

The skinner was a shorter man but it was obvious that there was great strength in his upper body. Also dressed in buckskins, his clothing had a greasy look and it was clear that there was dried blood on much of him. He carried a pair of knives in sheathes on his belt. One of them had a wide blade, curved upward at the pointed end. The other was smaller, more like a dagger. Both were sharpened to a razor's edge. In fact, when he shaved, he shaved with the shorter one.

The two men had little love for each other even though their lives were thoroughly intertwined. The skinner was simply hired help and his job as a hard one. He and the other skinner who was back a mile or so with the mules and wagons skinned the bison (buffalo) and cured the hides. They also loaded the hides on the wagons for the long trip to the rail head far to the north in Dodge City.

The big man was the hunter and the boss and he would make decisions that would tell whether he could make a profit and pay the skinners their wages.

The hunter and the skinners had found the buffalo herd north of the Red River on the Texas border a few weeks earlier. The herd was moving slowly northward, feeding on

the rich green grasses of the Oklahoma prairie. The hunters simply followed the buffalo, taking as many hides as could be skinned, dried and transported.

As the buffalo hunter and the skinner peered over the crest of the knoll, they gazed down on only forty or fifty animals. Evidently this group of animals had left the main herd a day or so earlier and moved into this shallow green valley by themselves. The hunter shrugged his shoulders silently, knowing he could kill more than enough to keep his skinners busy and catch up with the main herd later.

The hunter slowly went to his knees with his Sharps rifle in his right hand. He then inched forward until his elbows rested in the soft soil behind a smooth but small boulder. He reached in his side pocket and withdrew a handful of the large cartridges the big bore of the rifle took. The cartridges were placed in a pile on the ground to his right. The rifle was very heavy and he rested the long barrel on the granite boulder.

The skinner, now beside the hunter on the hill, pointed to a yearling calf at the edge of the herd. He knew that the young heifer would skin easily and also yield the most tender meat in the herd. They needed the meat because they had run out a day or two earlier. The hunter nodded, took aim and shot. The yearling's legs crumpled and she lay dead in a heap on the Oklahoma prairie.

The hunter knew that the sound of the rifle and the dying bison would probably not bolt the herd. The live animals would mill about nervously but probably stay long enough to insure a good kill. If any of the animals looked like they might run, they were killed quickly. He slipped another cartridge into the breech of the rifle and swung the barrel toward a cow heavy with calf. He barely felt the strong recoil but the cow felt the bullet tear through her lungs. She stood there for a few seconds blowing blood-flecked froth from her nostrils as she died. She rolled over on her side and her calf died soon afterwards inside her.

The killing went on for some time until enough bison lay dead or dying to keep the skinners busy for hours. These few dead bison were only a small number when one realizes that there may have originally been 50,000,000 buffalo west of the Mississippi River. But the killing was going on everywhere on the plains where the hunters could get the hides to a rail head for shipment eastward. And, too, the killing went on in some places simply for sport and in others to reduce the Indians' food supply. Those killed for sport or for political reasons were often just left to rot. Not even the hides were taken by the shooters.

There were four huge herds of buffalo on the Great Plains. Each had its own migration pattern, following the greening of the prairie grasses northward in the spring and southward to milder winters when the weather turned cold. This southern herd the hunter was after ranged from Texas northward to southwestern Kansas where its range overlapped the Kansas Herd. Northward into Wyoming and South Dakota ranged what was called the Republican Herd. Still northward into North Dakota, Montana, and Canada was the Northern Herd.

The southern or Texas Herd was huge and between 1872 and 1874 almost four million buffalo were killed out of it by white hunters and Indians. By 1879 the Texas Herd was gone and the plains of Oklahoma, Texas, and Kansas were littered with the bleached bones of millions of bison left to rot after their hides had been removed.

The end of the buffalo also spelled disaster for the Plains Indians. In the first quarter of the l9th Century there were probably 300,000 Indians on the Great Plains totally dependent on the bison. There were the Puncahs, the Mandans, the Minatarees, and Ricarees as well as others like the Sioux. The tribes had evolved with the bison and the Indian knew no other lifestyle. Whether on horseback on on foot, the Plains Indians were able to survive because of the enormous herds of buffalo that swept north and south each year.

For the Indian the bison meant meat, hides for clothing and shelter, armour in the form of shields that were arrow-proof, glue, jewelry, hair dressing and sinew. Further, the dried dung fueled fires that kept them warm on cold evenings on the prairie. Fall hunts allowed tons of meat to be dried to keep the tribes in foodstuffs through the winter.

During the days of plenty in spring and fall, feasts were commonplace in both Indian encampments and the camps of the trappers and fur traders. At these times, only the choicest cuts of meat were used with odd assortments of pieces being used with relish. Favorite cuts included the hump, the tongue and the intestines. It was not unusual for a man to sit down to a feast of the choicest cuts and consume eight pounds of meat before quitting. At these times the wolves and coyotes of the plains were bloated with all they could eat because the bulk of the buffalos was left unused by the feasting humans.

The coming of the white man to the Great Plains changed all of thia in a matter of a few short decades. The Texas Herd was the first to go and by 1883 the Republican and Northern Herds had been slaughtered to the point that it was uneconomical to hunt commercially.

In these few, short decades one can imagine what happened to the Indian. He went from an independent, healthy human being to one totally dependent on the whims of the white man. Those that had not been exterminated were herded into seemingly worthless pieces of real estate and fed with "government beef". New and terrible conditions brought about a breakdown in the culture and social structure of the tribes from which, to this very day, they have not recovered. The greed and savagery of the white man on the Great Plains tends to be a forgotten part of our heritage but it was very real and, in part, came about purposefully to push the Indian out of the way so that the plains could be ranched, farmed, and mined.

Part III

The Great Plains of North America covered a huge mass of land. The Great Plains stretched from the Mississippi River on the east to the Rocky Mountains to the West. North and south they existed from Texas northward into Canada. Most of the plains consisted of grasslands. There were the tall grasses to the east and the short grasses in the dryer, western portions of the Great Plains. The kinds of grasses that grew in different regions were controlled largely by the amount of rainfall - higher to the east and lower in the west.

For tens of thousands of years, the plains saw not one white man. These were the years during which an aboriginal American developed a very special relationship with the plains and the animals that lived there. This relationship was a fairly simple one in ecological terms. The basic relationship consisted of the following parts: (1) the soil of the plains, (2) the grasses of the plains, (3) the bison (buffalo), and (4) the Indian. All of these parts were interrelated. The ecologist might write these interrelationships like this: ***soil <-> grass <-> buffalo <-> Indian****. What does this mean?*

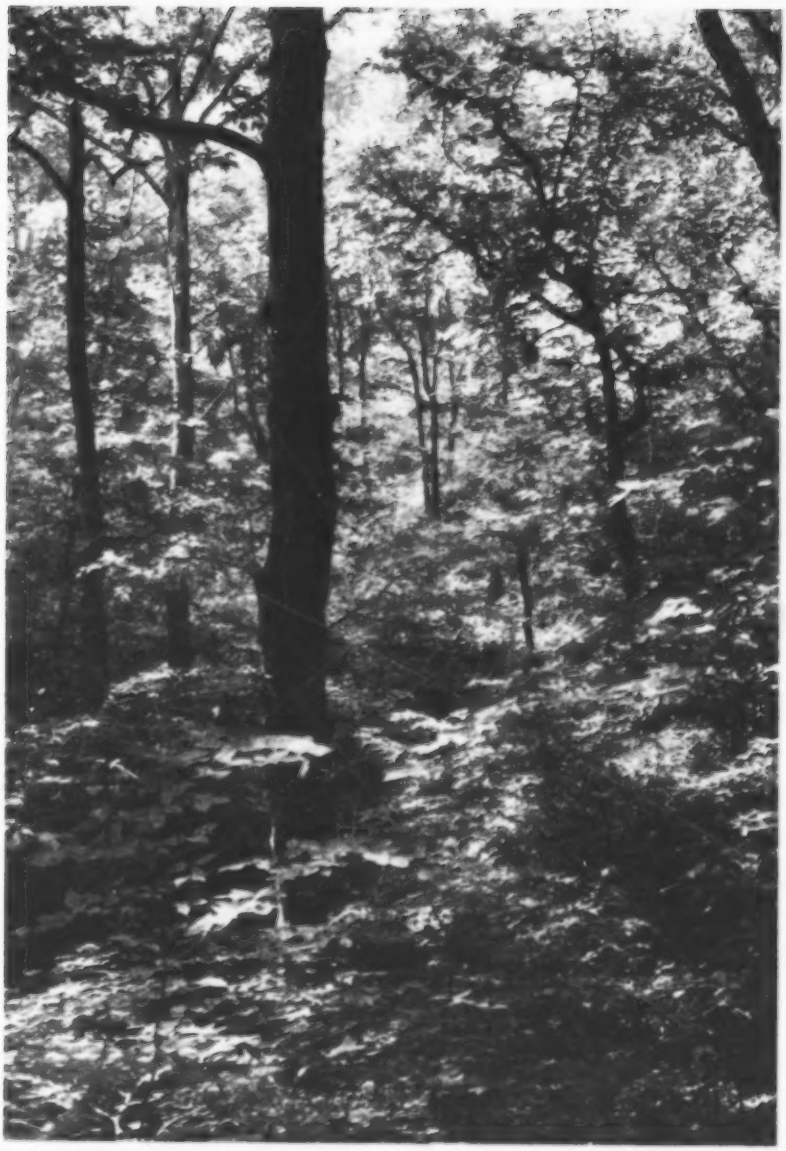
It means simply this. The grasses were dependent on the soil of the plains, the buffalo were dependent on the grasses, and the Indian upon the buffalo. We can also say that the Indian was, indirectly, dependent on the grasses and the soil as well. This soil <-> grass <-> buffalo <-> Indian relationship is fairly simple in ecological terms (there are far more complicated ones in nature). But, even though very simple, it was destroyed by greedy men selling hides and those who wanted the Indians and buffalo removed from the plains so that this huge land area could be used for other things. And, too, there is a lesson to be learned from all of this if modern men and women everywhere are intelligent enough to learn it.

No where is this lesson so well stated as in Durward Allen's book entitled <u>*Our Wildlife Legacy.*</u> *Dr. Allen writes:*

> *"... this soil-grass-buffalo-Indian relationship is a simplified replica of what modern men face in living on the earth's resources. Each item in the system is dynamic and exists by compromise with the others. When any one fails to compromise, there is trouble for the whole. The buffalo was an essential link between Indian and soil; and when the herds were destroyed, the result was immediate. Winter blizzards howled across empty campsites where only a decade before they had drummed against the taut sides of lodges."*

WHAT IS AN ECOSYSTEM

On the next few pages you will find photographs of ecosystems. At first glance these ecosystems appear to be quite a bit different from each other. Some have trees and some do not, some are land-based and some are not. All have different sets of plants and animals living in them. Still, they are amazing similar.



A temperate climate deciduous forest ecosystem in North America. (Photograph courtesy of Harold R. Hungerford.) The particular ecosystem seen here is dominated by beech and maple trees. However, as elevation increases in this area, the beech-maple forest changes to oaks and hickories. The reason for this change to oaks and hickories is mostly due to available moisture which is less on the sides and tops of the valleys.

A freshwater swamp in midwestern North America. (Photograph courtesy of Harold R. Hungerford.) The plants and animals of this ecosystem are markedly different than those of either the deciduous forest or the hot desert. The major variable here is a large amount of fresh water that slowly flows through this ecosystem. The depth of the water in the swamp may vary from a few inches to six feet or more.

A hot desert ecosystem in the southwestern United States. (Photo courtesy of Harold R. Hungerford.) This particular hot desert is called the Sonoran Desert and is located in Arizona. The Sonoran Desert is characterized by magnificent saguaro cactus plants. An amazing variety of plants and animals exist in this desert ecosystem. All are adapted for life in a very dry ecosystem which can be extremely hot during the day and cold during the night.

A number of things makes these ecosystems very similar, indeed. Each of these ecosystems contains various populations of plants and animals. These populations of plants and animals interact with each other in numerous ways. These populations of plants and animals depend on each other for their survival. In each, there are green plants that produce food and animals that somehow use part of that food for energy. The energy produced in each ecosystem flows through that ecosystem. This flow of energy keeps that ecosystem in existence because it fuels the organisms that live there. In every ecosystem we find different organisms gaining their energy in different ways. In each we find food producers, plant eaters, animal eaters, parasites, scavengers, and decomposers. These different roles, played by different organisms, keep energy and nutrients flowing through the ecosystem.

There are sets of physical and chemical factors in each ecosystem that control the character of that ecosystem. Moisture plays a role in each. Rainfall plays a role in each. Chemical nutrients play a role in each. The kind of soil plays a role in each. Topography plays a role in each. On and on. And, in turn, the living things in each ecosystem can heavily influence at least some of the physical and chemical factors in that ecosystem.

Other factors are similar across each ecosystem. Living things compete with each other in each one. Some of the competition is between members of the same population. Other competition exists between members of different species and, therefore, different populations.

In each ecosystem every animal and every plant has certain tolerance ranges within which it can survive. Beyond these tolerance ranges for such things as moisture and heat each organism is stressed or dies.

In each ecosystem every animal and plant must have its own role to play. No two organisms (species) can occupy the same role in any of these ecosystems. Otherwise, one species will become extinct in that ecosystem.

Thus, each ecosystem is similar to every other in many ways even though they appear very different. And, of course they are different in many ways. This is obvious. These similarities and differences are the things that we will learn about in this chapter.

Some Things That Make Ecosystems Similar

1. All have populations of plants and animals living in them.

2. The plant and animal populations interact with each other.

3. The plant and animal populations are dependent on each other.

4. Plants produce food in ecosystems.

5. Energy flows through ecosystems from the food produced by plants.

6. The flow of energy is necessary to the survival of the ecosystem.

7. Different organisms get their energy in different ways.

8. Important physical and chemical factors are present.

9. Each plant or animal species plays a different role in an ecosystem.

10. Each plant and animal species has a tolerance limit for various things in its environment.

DEFINING THE "ECOSYSTEM"

Perhaps, before going further, you would like to try your hand at defining "ecosystem". You now have a better idea of what an ecosystem is than you did before you started looking at this chapter. You know that an ecosystem is made up of populations of plants and animals. You should know that these plants and animals are interrelated in numerous ways. You know that energy flows through ecosystems. Just how would you define this term?

Ecologists tend to define ecosystems as populations of plants and animals living in a given space and interacting with each other and their physical environment at a particular point in time. So, space is important, time is important, physical variables are important, and interacting plants and animals are important. The key words are space, populations, physical variables, interactions, and time. It's how you put these words together and how you view them that is important.

A diagram of this definition can be found on the next page.

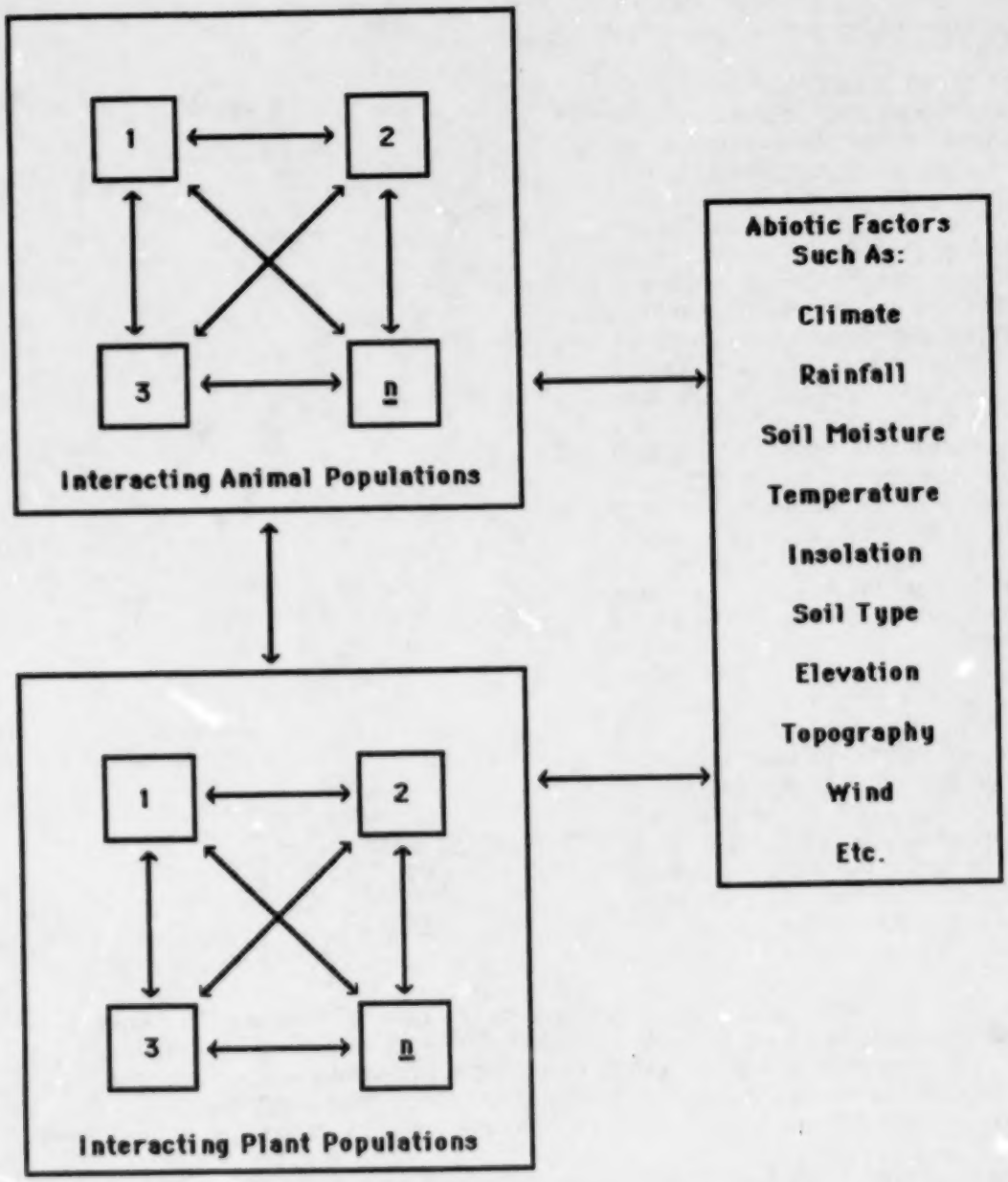
MAJOR FACTORS IN THE ECOSYSTEM

Energy to Drive Ecosystems

As was noted earlier, energy is a very important element in allowing ecosystems to exist. It is commonly said that, "Energy drives ecosystems". What does this mean? Where does this energy come from? Where does it go? Let's consider these questions.

Because populations and plants and animals are basic ingredients in ecosystems, the elements for their survival have to be in that ecosystem. Of course, a plant or an animal needs to be able to store energy and use it in carrying out its life functions. And, since populations of organisms are made up of individuals of the same species, it takes a lot of energy to keep that population functioning. This energy comes from food. But, that food has to come from somewhere. Remember, there are no food stores or super markets in a forest, desert, pond, or savannah.

AN ECOSYSTEM MODEL



An ecosystem is made up of interacting populations of plants and animals. These in turn interact with the nonliving or abiotic variables forming a complex system, called the "ecosystem".

The food that drives ecosystems is manufactured by green plants. Green plants contain chlorophyll. Chlorophyll has the amazing ability to take water and carbon dioxide and combine it to form carbohydrate molecules in the presence of sunlight. In the process, the green plants give off oxygen. The energy for this food production comes from the sun. So, in effect, green plants are locking the sun's energy into the carbohydrate molecules through the food making process (photosynthesis).

The green plants, of course, store some of this energy and use some of it for their own life functions. But, the storehouse of energy locked up in green plants (be they microscopic algae or gigantic tropical rainforest trees) is available for use. Many, many animal species use it. Plant eating animals (herbivores) tap this energy resource in lots of different ways. Some bore into large green plants (like wood-boring insects). Some eat the plant whole (like ducks feeding on duck weed). Some eat foliage (like antelope). Some eat pollen (like bees). Some drink nectar (like hummingbirds). Some feed on roots (like rodents or humans feeding on sweet potatoes). This storehouse of energy is just too good to pass up and a great variety of animals have learned how to unlock the storehouse. Thus, the energy that plants have produced is passed on to the plant-eating animals.

But, there is more to the story of energy than this. Where do the meat eating animals get their energy. Of course, many of them kill and consume the plant-eaters. A few examples are coyotes, humans, owls, weasels, shrews, snakes, and many birds. You should be getting the idea that the energy that was originally produced by green plants is actually flowing through the system. This is exactly what is happening.

The story doesn't end here. There are animals that eat many of these animals. And, there are other animals that have developed still different ways of getting food energy. There are the scavengers that feed on dead or dying organisms (crabs, vultures, hyenas, etc.). There are also the decomposers - mostly plants that process dead material in order to get the energy they need for their life functions (mushrooms, decay bacteria, etc.).

So, energy does, indeed, drive ecosystems. Energy is an integral and necessary part of ecosystems. It is critical to the very existence of the ecosystem.

The Abiotic Variables

The animals and plants of an ecosystem make up the living or biotic part of the system. There is also, however, another set of variables that is crucial. These variables are the nonliving or abiotic variables that control the character of ecosystems.

Perhaps the most important single abiotic variable is **climate**. Climate is probably responsible for the existence of more ecosystems than any other. Climate is typically defined as the day-to-day weather conditions in a given area over a long period of time. This day-to-day weather is made up of variables such as daytime temperatures, nighttime temperatures, season changes in temperatures, precipitation, humidity, etc. You should quickly realize why tropical rain forests could not grow where desert ecosystems thrive. The climate of a tropical rain forest is much different than that of the desert.

Although there are many exceptions, climate tends to control ecosystem development around the world according to how far the ecosystem is from the equator. We usually find tropical rain forest ecosystems at or close to the equator. North of the tropical rain forests we find deciduous forest ecosystems. North of the deciduous forests we find coniferous forest ecosystems. North of the coniferous forests we find the tundra. This is mostly a function of climate.

Although climate is extremely important, many other abiotic variables play important roles in developing ecosystems. In the above paragraph it was noted that deciduous forests are typically found north of tropical rain forests. Deciduous forests lie in temperate regions of the world - in Europe, North America, parts of Asia and other temperate regions. However, numerous kinds of deciduous forests exist. In North America, for example, one can find beech-maple forests and oak-hickory forests as well as others. Why different kinds of deciduous forests?

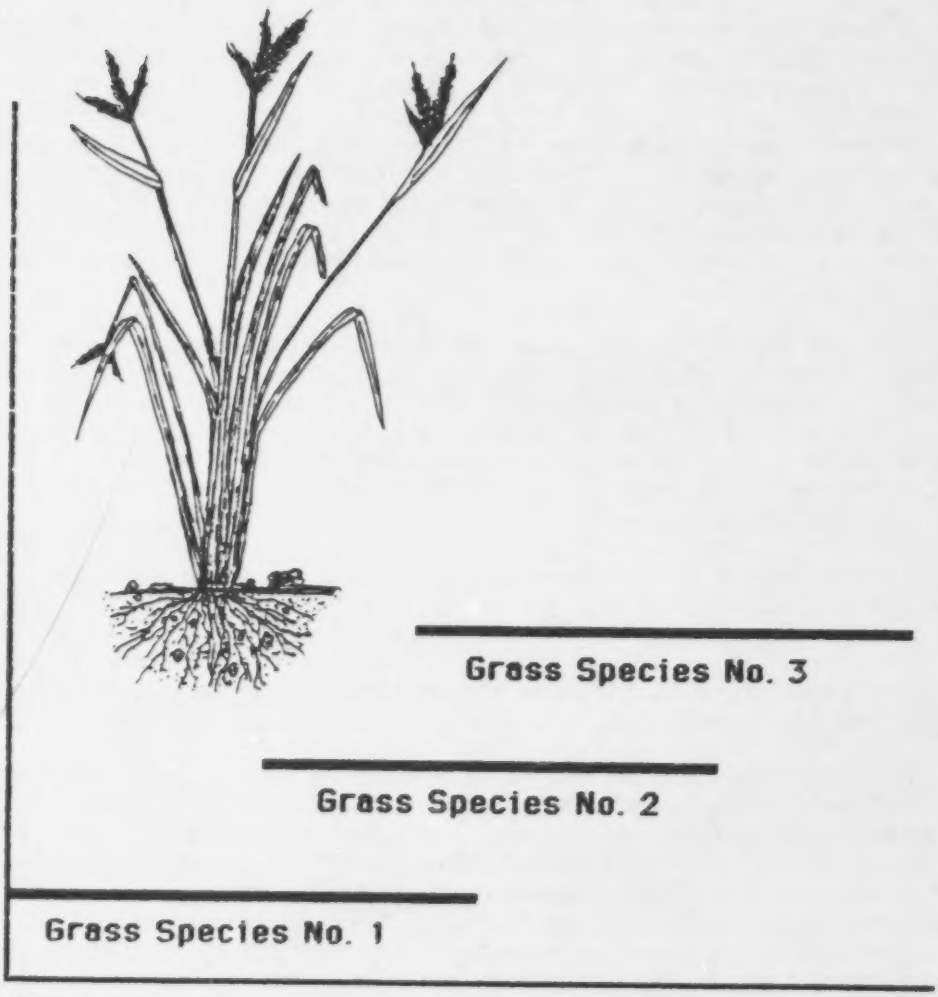
The key factor in determining whether one finds a beech-maple forest or an oak-hickory forest is **soil moisture**. Beech-maple forests typically need greater soil moisture than oak-hickory forests. Yet, we often find beech-maple forests growing very close to oak-hickory forests. How can this be? Often, it is a case of the oak-hickory forest growing at a higher slope **elevation** than the beech-maple forest. More moisture collects on the slopes beneath the oak-hickory forest and, therefore, a beech-maple forest can develop.

Elevation also works in other ways to control the development of ecosystems. Just as with the deciduous forest example seen above, elevation works in conjunction with other abiotic variables. Let us look at elevation in mountainous regions. In the American West, one can begin a journey up a mountain and start this journey in rather dry pinion pine - juniper forests. Scattered pinion pines and junipers share a dry semi-arid soil. But, as one begins the ascent up the mountain, the pinion pines and junipers give way to other kinds of evergreen trees - ones that need a cooler **temperature** and more **moisture**. These evergreen trees give way to still different coniferous trees where it is still colder and wetter. Eventually, if the mountain is tall enough, all trees are left behind and one enters an environment that experiences severe weather with a very short growing season and substantial moisture. This would be the mountain alpine ecosystem.

Thus, elevation works to control the development of ecosystems by controlling the climate at different elevations. As moisture laden air is pushed against the mountain and forced upward, it becomes cooler very quickly. Cold, moist air cannot hold as much water as warm, moist air. Therefore, **precipitation** results. In many mountainous areas, almost all of the moisture in the air is released as precipitation before the air crosses the mountains. When this happens, a desert may be found on the other side of the mountains. When mountains force moisture out of moving air masses we call this the "rain shadow phenomenon"

Topography is closely associated with elevation but differs in a number of ways. Topography refers to the ups and downs (undulations) of a region. It involves hills, valleys, slopes, plains and numerous other features. Topography is very much involved in

MOISTURE REQUIREMENTS OF THREE GRASS SPECIES



This diagram represents three grass species on North American grasslands. Grass species No. 1 needs more moisture for survival than either species No. 2 or 3. Grass species No. 3 is adapted for survival on the dry grasslands of the western Great Plains.

ecosystem development. It was, of course, involved in the development of the beech-maple forest example read earlier. Topography is also involved in the formation of water-based ecosystems such as swamps, rivers, ponds, and lakes.

A very important abiotic variable is **insolation**. Insolation refers to the amount of sunlight falling on a particular area. When insolation is combined with what is called "slope exposure", some interesting things may happen. Let us assume that a valley runs east and west in a desert ecosystem. The north-facing slope of that valley receives less sunlight per unit of space than the south-facing slope. Because of this, the south-facing slope is **hotter** and **dryer** than the north-facing slope. This impacts on the plants and animals as well. On the south-facing slope we may find many cactus plants and few shrubs. On the north-facing slope the reverse is true. There will be many shrubs and fewer cactus plants. It is quite logical to assume that the animals associated with cactus plants will be found on the south-facing slope and those associated more with shrubs will be found on the north-facing slope.

It is interesting to note that, in an ecosystem such as the desert discussed above, plant and animal communities may vary within that ecosystem. Although the desert's north and south-facing slopes had rather different plant and animal communities on them, they were still both desert communities within the desert ecosystem.

Other abiotic factors play important roles in ecosystems. We find that variables such as **humidity, shade, soil type, rock substrate, wind velocity** and others have a lot to do with the character of many ecosystems. It is, therefore, quite common for people to correctly assume that abiotic variables control the character of ecosystems. What many people forget is that biotic variables also influence abiotic ones.

Let's consider how biotic variables influence abiotic ones. Some very important environmental considerations are coupled with this phenomenon. If we walk down a rural road on a hot, summer day we may notice the intense **sunlight**, the **heat**, the **humidity**, and the **wind currents** there. **Moisture** in the form of sweat collects on our bodies and **evaporates** with the help of the wind currents. If we come upon a wooded area and enter it, we immediately notice a far different environment. The sunlight is reduced a great deal by the **shade** of the trees in the woods. It seems much cooler. The **wind velocity** is reduced. The sweat on our bodies evaporates more slowly because of fewer air currents and higher humidity in the woods. All of these things have changed because of the presence of the woodland. In addition, if we were to measure some abiotic variables with instruments, we would probably find that **soil moisture** was higher in the woods than in the open area. **Soil temperature** would be lower in the woods than in the open.

This very brief introduction to biotic and abiotic variables should tell you two things: (1) there are many living and nonliving variables to consider when trying to understand how ecosystems operate, and (2) many variables work in complicated and interconnected ways to control the character of ecosystems.

-Activity-
Biotic and Abiotic Variables:
A Two-Way Street?

Instructions For The Student:

The worksheet below contains a list of some of the abiotic variables that can influence an ecosystem. For each, you are asked to consider whether it impacts on the ecosystem chosen for this activity. If you answer "yes", you are asked to state how it might impact on this particular ecosystem. Further, for each, you are asked to try and determine whether this abiotic variable is influenced by the living components of this ecosystem. If you think it is influenced, please identify what might be influencing it. This is not a particularly easy task to do. A lot of good thinking is necessary.

The kind of ecosystem on which this activity focuses: _____

1. Climate
   Does it influence this ecosystem? Yes ___; No ___. If so, how?

   Does the ecosystem influence climate? Yes ___; No ___. If so, how?

2. Topography
   Does topography influence this ecosystem? Yes ___; No ___. If so, how?

   Does this ecosystem influence topography? Yes ___; No ___. If so, how?

3. Precipitation
   Does precipitation influence this ecosystem? Yes ___; No ___. If so, how?

   Does this ecosystem influence precipitation? Yes ___; No ___. If so, how?

4. Elevation
   Does elevation influence this ecosystem? Yes ___; No ___. If so, how?

   Does this ecosystem influence elevation? Yes ___; No ___. If so, how?

5. Soil Moisture
   Does soil moisture influence this ecosystem? Yes ___; No ___. If so, how?

   Does this ecosystem influence soil moisture? Yes ___; No ___. If so, how?

6. Humidity
   Does humidity influence this ecosystem? Yes ___; No ___. If so, how?

   Does this ecosystem influence humidity? Yes ___; No ___. If so, how?

7. Shade Does shade influence this ecosystem? Yes ___; No ___. If so, how? Does this ecosystem influence shade? Yes ___; No ___. If so, how?
8. Wind Velocity Does wind velocity influence this ecosystem? Yes ___; No ___. If so, how? Does this ecosystem influence wind velocity? Yes ___; No ___. If so, how?
9. Soil Type Does soil type influence this ecosystem? Yes ___; No ___. If so, how? Does this ecosystem influence soil type? Yes ___; No ___. If so, how?
10. Other than climate, what abiotic variable seems to be most important to the development/survival of this ecosystem? You can choose one not listed above if you feel that another is most important. _____ Why did you answer as you did?

TWO IMPORTANT CONCEPTS: HABITAT AND NICHE

Habitat

In an ecosystem, every plant and animal lives in a habitat. Although you might think that an ecosystem is one very large habitat, it is more complicated than that. Different parts of ecosystems produce different habitats. In a pond, for example, there is an edge that is wet but not covered with water. There is a shallow water area, deeper water areas, and some sort of pond bottom (e.g., mud, rock, gravel, etc.). In or on each of these habitats, particular plants and/or animals live. Therefore, a plant or animal's **habitat** is where it lives.

In an pond ecosystem we often find cattails and sedges growing at the pond's edge. In shallow water we might find pond weed and filamentous algae. In deeper water we might find single celled algae (phytoplankton). And, we might find larger aquatic plants rooted in the soil of the pond's bottom and growing up through the pond's surface. On the pond's surface we might find duckweed floating freely across the surface. Each of these plants (and others) has it own special habitat in the pond ecosystem. Animals are the same way. You won't find an edge-loving heron in deep water. You will seldom find a catfish at the edge of the pond. You find them in their own habitats.

Various plants and animals may share very similar habitats. But, each kind of animal or plant is dependent on a particular habitat for its very survival. In fact, habitat is the most critical variable in an organism's existence. Remove the habitat and you effectively remove the organism as well. This concept has tremendous implications for many of man's activities.

Niche

It is often written that an organism's habitat is its "address" or, where it lives. Another concept, the **niche**, deals with how the organism lives. The niche is often referred to as the organism's "occupation" in an ecosystem.

It is relatively easy to describe an organism's habitat. It is not nearly so easy to describe an organism's niche.

The niche concept is a difficult one. Most ecologists will admit that it is probably impossible to completely identify an organism's niche. Even so, it is important to try to understand the niche of an animal or plant because the niche tells us the role that animal or plant plays in the ecosystem. And, in order to fully understand how ecosystems work we must try to understand organisms' niches.

An attempt to describe an organism's niche must include its habitat, how it gets the food (energy) it needs, the species it competes with, and how, where and when it reproduces. It must also include the organism's abiotic requirements, its tolerance limits, and how it influences abiotic variables.

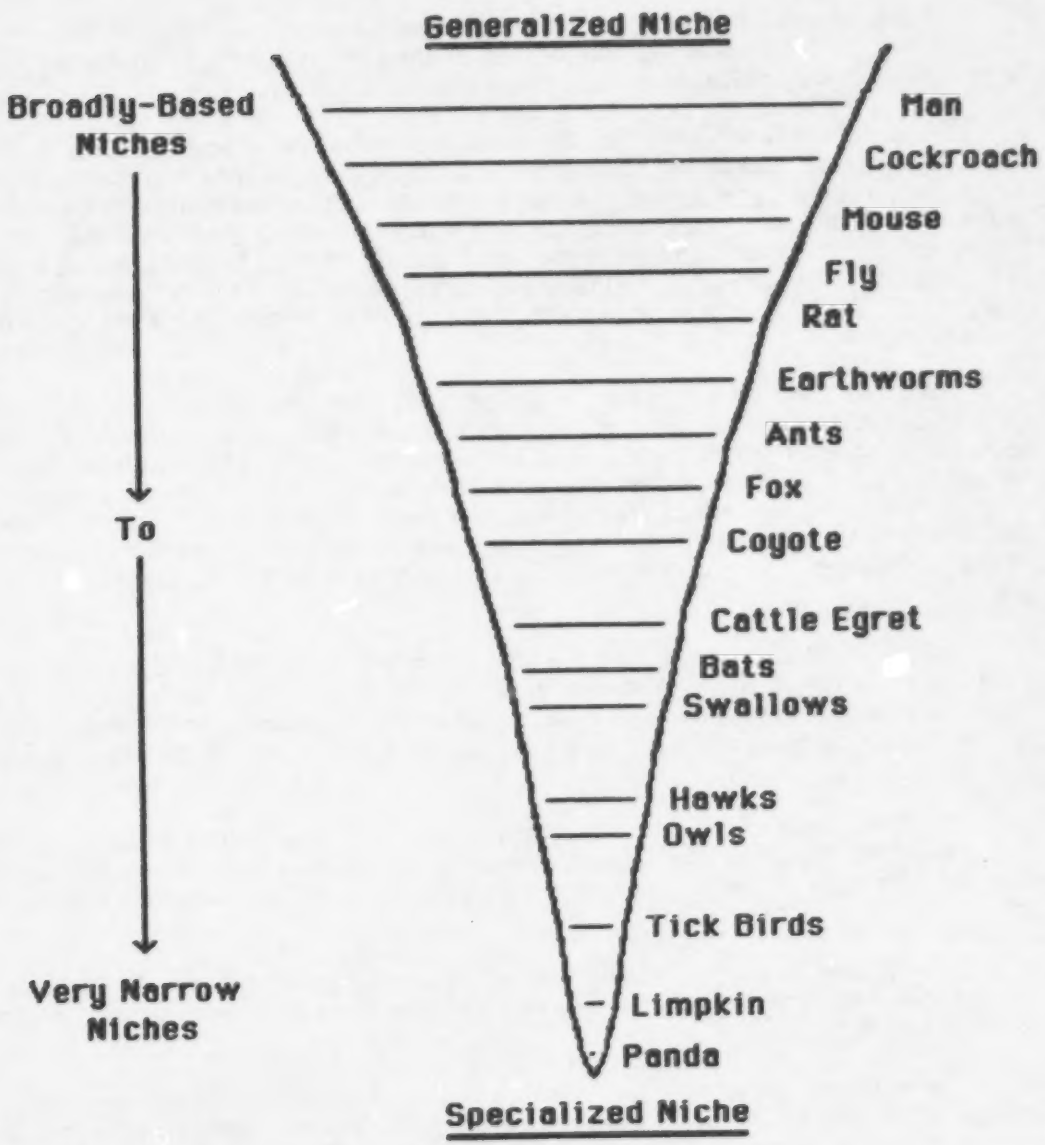
Earlier you read that different roles, played by different organisms, keep energy and nutrients flowing through an ecosystem. These roles (also referred to as niches) include food producers, plant eaters, animal eaters, parasites, scavengers, and decomposers. One must not assume that different organisms fill each of these food niches the same way.

It would be easy, for example, for the beginning student of ecology to assume that different species of owls function in their niches the same way. If we look at owls' niches in the great Southwest U.S.A. deserts, the differences are dramatic. The elf owl lives and nests in wood or cactus cavities and eats many insects. The burrowing owl lives in burrows in the ground, is often out in the daytime, and eats numerous small mammals. The barn owl nests in barns, abandoned buildings and tree cavities. It is strictly nocturnal, feeding mostly on mice, voles, and rats. Other owls fill their niches in remarkably different ways. No two owl species in the desert will have exactly the same niche. If two species of owls had identical niches, one of the owl species would most certainly out-compete the other and drive it from the desert.

Ecologists know that some plants and animals have rather broad niches (called generalized niches) and some have very narrow niches (called specialized niches). Those with generalized niches are very successful because they can function well in different habitats. Examples of these would be man, cockroaches, rats and poison ivy.

Animals and plants with specialized niches are successful only in special habitats or under special conditions. These are successful only when these conditions are met. Examples of these would be some orchid species, pandas, the snail-eating limpkin, and Kirtland's warbler. Many animals and plants with specialized niches have been identified as threatened or endangered species. Why is this the case?

SPECIALIZED AND GENERALIZED NICHES
Some Examples



THE LAYERING CONCEPT

As beginners, we tend to look at ecosystems as a whole, unable to sort out their parts, study those parts, and then put them back together in a more meaningful way. Ecologists and advanced students of ecology try to do exactly this - look at an ecosystem's parts so that the parts can be studied in terms of their role in that ecosystem.

Ponds, grasslands, forests and other systems have more or less obvious layers. These layers can be given names and identified. Once this is done, we can look at those layers and study their role and how they function in the ecosystem.

A deciduous forest in the U.S., for example, appears to have several distinct layers. These layers have been named. These are: (1) the canopy layer or the upper reaches of the largest trees, (2) the understory layer which is made up of numerous smaller trees growing in the shade of the canopy, (3) the shrub layer which is made up of woody shrubs growing beneath the understory (and sometimes missing in the forest), (4) the herb layer which is made up of soft-stemmed plants that grow, reproduce, and die back to the ground each year, and (5) the litter and soil layer which is made up of the organic debris and soil of the forest ecosystem.

We find that each level (layer) in the forest has a definite role to play in the forest. Of extreme importance is the fact that each layer provides a habitat for a particular group of animals. Each layer, for example, has its own species of birds. These birds are not restricted to a given layer but they are most often found in "their layer". This phenomenon is diagrammed on the next page. We find the oven bird near or on the litter and soil layer. We find the scarlet tanager in the canopy. Only seldom will one of these birds invade the habitat of the other. The niches of these birds are very, very different as you might imagine.

Other animals, of course, have full time or part time niche relationships with certain forest layers. A few of these animals would be: (1) millipede and centipede (litter and soil layer), (2) rabbit (herb layer), (3) catbird (shrub layer), (4) opossum and blue-gray gnatcatcher (both have part time relationships with the understory), and (5) the flying squirrel (canopy).

It is important to understand that each forest layer plays a part in maintaining the total ecosystem. It is crucial for the forest to have a canopy, an understory, and a litter and soil layer. These layers are very interrelated (interdependent). Can you explain why this is so?

Sometimes, as noted earlier, the shrub layer is missing in the forest. Still the forest survives. However, the animals that depend on a shrub layer for a niche habitat are very scarce or absent.

Here we see two very different ideas: (1) some ecosystem parts are very interdependent (they need each other to make the system work) and, (2) sometimes a part of an ecosystem can be missing and the ecosystem can survive. These are exactly the kinds of things ecologists need to know in order to understand ecosystems and be able to make good predictions about what will happen if a part or layer is destroyed. Why is this so very important?

LAYERS IN A TYPICAL
DECIDUOUS FOREST

Canopy Layer >

Understory Layer >

Shrub Layer >

Herb Layer >

Soil and Litter Layer >

[Note: As explained at the beginning of this model chapter, this chapter is incomplete and presented here as a model of how content can be developed for middle school students. However, the writers wish to present a culminating activity that should be used as an evaluation tool subsequent to instruction. This culminating activity is called "The Ecosystem Observation Activity" and has been used many times by the writers in their work in environmental education. This activity not only evaluates student progress but it is a very good indicator of the success the instructor has had in presenting material and providing activities for learners.]

The Ecosystem Observation Activity

Instructions For The Student:

Your instructor will provide detailed instructions about how you are to complete this assignment. This Ecosystem Observation Activity is designed to see how well you can go into an ecosystem and observe components of it. You need not know the names of every plant and animal you will observe in the ecosystem. The questions which follow will help you focus your observations. The activity is a rather long one so you can expect that it will take some time to complete.

Your Name: _____, _____ Date: _____

1. Identify the kind of ecosystem you are observing. Is it a hardwood forest? A savannah? A grassland? A desert? A pond? Just what is it you are observing?

2. Do you believe that this ecosystem is a dominant one in the region in which you live? In other words, is this an extensive living system in the region? Yes ___ ; No ___. Why did you answer as you did?

3. Can you identify the exact boundaries of this ecosystem? Yes ___ ; No ___. What might be some of the difficulties encountered in identifying this ecosystem's exact boundaries?

4. What are the overall (general) characteristics of the ecosystem you are observing? Be sure to include the plants that seem to dominate this system?

5. What are the abiotic (nonliving) variables that seem to be controlling the character of this system? For example, what might be the influence of things like topography, rainfall, temperature, humidity, etc.? How do these abiotic factors appear to be controlling the character of this living system?

6. What populations of plants and/or animals can you observe here? What is your evidence?

7. Living organisms are called "biotic factors". Can you identify any biotic factors that seem to influence the overall character of this system? Identify those that do and explain how you think they influence the ecosystem.

8. Is there any evidence of layering in this ecosystem? If so, how would you describe the layers?

9. Can you observe any evidence of competition between members of a given population? Yes ___; No ___. If so, name the population and explain what they seem to be competing for.

10. Can you observe any evidence of competition between members of different species? Yes ___; No ___. If so, name the populations and explain what they seem to be competing for.

11. Can you observe any interactions between members of different populations other than competition? Yes ___; No ___. If so, how is each organism affected by the other?

12. What evidence exists that food energy flows through this ecosystem?
(If it would be helpful for you to diagram this flow of energy please feel free to do so.)

13. What evidence exists, if any, to indicate that this ecosystem is more or less stable over time? You would want to think in terms of years and decades and, perhaps, centuries.

14. Does man, in any way, play a role in this living system? Yes ___; No ___.
(Rarely would the answer be "No"!) Explain man's role in this ecosystem.

15. Is there any evidence that man's activity in this ecosystem threatens it, or any part of it, in any way?

Appendix II

Solid Waste Management Case Study (Abbreviated)

A Sample, Abbreviated Case Study for Environmental Science, Year Two

Reference: Chapter III

Year Two, Part X

An Introduction to the Solid Waste Case Study for the Reader

This case study is adapted from one under development by the authors which will be published in 1989 by Stipes Publishing Company, 10 Chester Street, Champaign, Illinois 61820 (USA). Readers interested in obtaining the entire case study for use at the middle school level should write to the above address.

The case study model recommended by the writers is typically developed around four (4) instructional levels. These include: (1) science foundations, (2) issue awareness, (3) issue investigation, and (4) citizenship action. This development format permits educators to take students from science content and issue awareness to citizenship action within the confines of the treatment of a single issue. By using a series of case studies as part of the EE curriculum, students should become aware of a large number of important issues and confident in their abilities to investigate serious issues and work toward solutions.

This case study as presented in this appendix is simply a model, one which can be used for the development of other case studies dealing with other crucial environmental issues. Unfortunately, space does not permit the writers to present the entire case study.

In the development of case studies based on this model, the writers, typically, use the following sequence of components (i.e., parts) for instructors to use in their orientation to the case study and for teaching the case study itself:

1. A flowchart of activities within each of the four instructional levels.

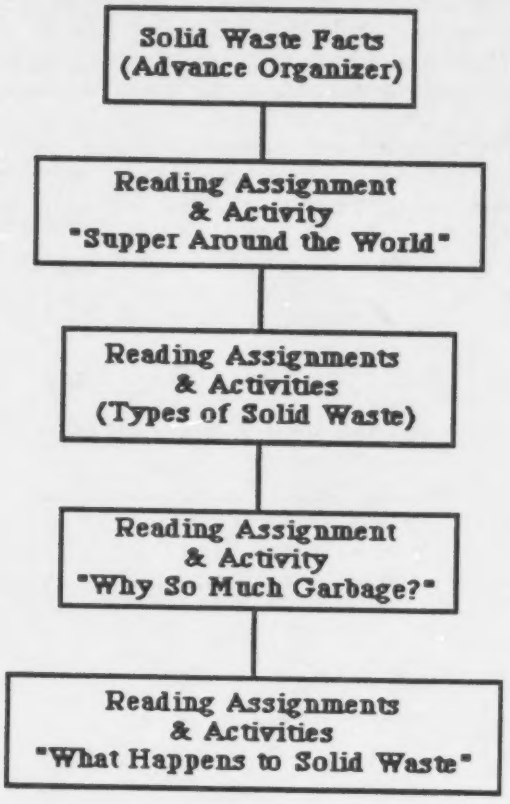
2. Learner objectives (i.e., performance objectives) for each instructional level.

3. Teacher notes regarding student activities, i.e., a teacher's guide for each instructional level.

4. Printed matter and activities for each instructional level for use with students.

SCHEMATIC OF ACTIVITIES FOR GOAL LEVEL I

SEQUENCE



LEVEL I: SCIENCE FOUNDATIONS

Citizens and governments the world over are increasingly faced with problems and issues concerning the production and disposal of solid waste. For the industrial countries the problem is dealing with an increasing volume of waste, coupled with the rapidly decreasing availability of traditional disposal sites. For less developed countries the problem concerns developing solid waste management programs which could help to improve human health.

Consider the following solid waste facts:

1. The world is producing between 500 million and a billion tons of solid waste per year. These figures could double every 15 years.

2. Each year Americans throw away approximately 60 billion cans, 28 billion bottles, four million tons of plastic, 40 million tons of paper, 100 million tires and three million cars.

3. Only about one-fourth of the paper, aluminum, iron, and steel used in the world is recycled.

4. Americans make up 5% of the world's population and annually produce about 30% of the world's solid waste.

5. More than half the cities in the United States will exhaust existing landfills by 1990.

6. Many ocean beaches have had to be closed because medical and other solid waste have floated on shore.

7. Open dumps, with insects and rodents, are typical of waste disposal sites in less developed countries.

8. Four thousand trucks and 20,000 cars are junked every day in the United States.

These facts highlight a few of the disposal practices and problems facing citizens of the world. The instructional unit that follows has been prepared to make you knowledgeable about the problems and issues concerning solid waste, and able to do something about them. Much of this case study will focus on only a part of the solid waste issue - municipal solid waste (from homes and businesses).

Supper Around the World

The people of different countries have different customs and attitudes about solid waste. The following persons have been asked to tell about about a typical evening meal in each of their countries. They have also been asked to tell how the household waste from that evening meal is usually disposed of.

Lucy, from Cameroon:

In the Cameroons of West Africa an evening meal typically consists of beef, greens, corn meal, yams, plantains, and water to drink. These foods are obtained daily from the merchants selling from stalls in the open-air market. Portions of fresh beef are cut from carcasses hanging in the market. Fresh vegetables are sold by farmers who brought their produce to the market from nearby fields. As foods are purchased they are sometimes wrapped in paper for protection. Sometimes they are simply placed in the shopper's market basket. Beer and other beverages sold in bottles require a deposit. Many people simply take their own bottles and have them filled. Some food products are sold in metal cans.

After the evening meal leftovers are sometimes fed to the pets. Unusable material is wrapped in paper and picked up every other day by the city's garbage service. Solid wastes are taken to an open dump outside of town and burned. Smaller villages sometimes dump solid waste in nearby streams and rivers. There are been reports of sickness caused by polluted water. Some waste is discarded as litter along the side of highways and roads.

Greg, from Paris, France:

Paris is a modern, crowded city. Space is a big problem. Most people live in apartments, and this fact greatly influences their behavior. Because apartment refrigerators are small, most people shop daily. Foods are obtained from local groceries and speciality shops like the butcher and baker. And there are still a lot of open-air farmers' markets. Frozen and convenience foods are available in larger groceries, but fresh food is typically the choice. Prepared foods are wrapped in paper or plastic, or canned. Fresh foods are placed in paper or plastic bags. Meals feature beef or poultry, bread and pastries, lots of vegetables, and often wine. Parisians do not drink water from the faucet. Instead, bottled water is purchased for human use. Most of the food products available are from the French countryside. However, international foods like pasta, taco shells, South American coffee, and hot dogs are also available.

Meal leftovers are usually refrigerated. Unwanted waste is bagged and sent to the basement of the apartment building via a garbage chute. Sometimes this material is sorted and recyclable materials are saved. A garbage service picks up waste, and it is buried in a landfill outside the city. Various efforts are made to keep the city clean and litter-free. Sidewalks and streets are washed. Special motorcycles clean up animal wastes from the sidewalks.

Bene, from Rumania:

Many food products are sometimes difficult to find in my country. Shopping must be done daily, and products are purchased when they are available. Meals usually consist of vegetables with cold meat like salami, or cheese or eggs, with tea or water to drink. Most of the food is grown regionally within my country and sold in small groceries and shops. Most of the food products are wrapped in paper until they are used. Meal leftovers are usually saved. Solid waste is placed in garbage bins and collected several times a week by collectors. Waste is taken to a dump outside of town and burned.

Citizens are encouraged not to litter, and anti-littering laws have been enacted. Many trash cans are placed in parks and on street corners in towns and cities. There is, however, no recycling of paper or metals.

Dana, from Mexico City:

Lots of food choices are available in my town, a suburb of Mexico City. Evening meals might consist of warm or cold meats, rice, vegetables, and fruit. These are purchased in food stores, shops, or corner markets. Most of it is fresh and grown in the region. Many products can be purchased in cans. A few large stores in wealthy sections of the city have a variety of food products imported from other countries.

Solid waste is bagged and saved until a private garbage collector comes around. This occurs on a varying schedule. The waste is then taken to the street. A fee is paid to the collector; and it is hauled away to a huge dump near the city. Mountains of waste from millions of people have been piled here for years. It has become a setting for diseases and rodents. However, there are people who sort through the waste at the dump looking for items or materials of value.

There are no programs to promote recycling or reduce littering. If trash or garbage cans are left outside unattended, they are stolen. Many streets and parks tend to be littered and dirty. There probably are littering laws, but they are not respected or enforced.

Scott, from the USA:

Our grocery stores are filled with all kinds of foods from many parts of this country as well as from around the world. These products might be frozen, fresh, canned, or precooked. Meals might consist of seafood, chicken or beef, vegetables, fruits, breads and pastries. Potatoes, for example, are available in more than 15 forms ranging from raw potatoes to flavored potato chips to pre-browned microwave fries. These types of potatoes are an example of the wide variety of specially prepared "processed" foods. Most products are packaged to make them appear attractive and convenient, and to make storage and transportation easier.

Solid wastes in my country are usually picked up by a trash collector and buried in a landfill. Some waste from coastal cities is towed to sea and dumped. A few large cities have trash incinerators in which solid waste is burned with the ash buried in landfills. Some individuals recycle, but only four states have implemented state-wide recycling plans. Litter is common in all public places and along highways and roads. Some solid waste is dumped in rural areas along roads or in mine pits.

Hussein, from Jordan:

Evening meals in Jordan consist of beef, cheese, and vegetables, with water to drink. Most of the food products are grown in the nearby countryside and sold fresh in small markets, shops, and by street vendors. A number of canned goods are available, but there are few processed foods. Most people shop daily to buy the food products needed for that day. Leftover food is saved, although refrigeration is not common.

Solid waste is picked up weekly by the city's trash collectors. In the large cities this waste is burned in specially designed, recently built waste incinerators. The ash from the incinerators is buried nearby. In small villages there is no waste collection system, and waste is dumped by individuals, sometimes in open pits and sometimes in rivers. There is no recycling, and litter is a problem along roadsides and in vacant areas.

Activity 1. What is the typical supper in <u>your</u> home? How does it compare with other suppers around the world?

A. Write a paragraph describing a typical supper in your own home. As part of that description, explain how it is obtained, how it is packaged, and how wastes are disposed of after the meal is completed.

B. Now, compare what you have written with the information in "Supper Around the World". In particular, look for differences in:

1. sources of food.
2. packaging of food.
3. disposal of wastes associated with the food and packaging.

What is Solid Waste?

Solid waste is any unwanted or discarded material that is not a liquid or a gas. Solid waste would include things like junk mail, newspapers, leftover dinner scraps, raked leaves and grass clippings, bottles and cans, appliances and furniture, abandoned cars, sewage sludge, fly ash, mining and industrial wastes.

Much solid waste consists of **agricultural wastes** such as manure and crop residues including nut shells, fruit pits, corn cobs, grain hulls, and vegetable and fruit peelings. Most of this material is not a disposal problem. Many of these materials are plowed under, composted, or used as fodder.

Solid waste also includes **mining wastes** such as rock, dirt, sand, and slag. About 60% of all the materials mined end up as waste. This material is often piled in heaps. This creates unattractive visual images as well as safety hazards. **Industrial wastes** include plastics, scrap metal, paper, fly ash, and sewage sludge. Some are classified as "hazardous" and must be disposed of under special disposal conditions.

Municipal wastes are from homes and businesses. These can include plastics, glass, food, rubber, yard waste, metal, paper, wood, and miscellaneous materials. In the U.S.A., a typical family's solid waste consists of paper (30%), yard waste (16%), food waste (15%), metal (10%), glass (10%), plastic (6%), and other material (6%). As you can see, paper is the single largest contributor to solid waste in the U.S. About a third of the solid waste consists of some form of packaging - glass, steel, and aluminum containers, paperboard, and plastic. Food and yard waste account for another 30-40%, depending on the season. These figures also depend to a great extent on where a person lives.

Hazardous Household Wastes

Some household and commercial waste is classified as "**hazardous**". Waste is hazardous if it is . . . (1) <u>ignitable</u>, with a flash point of less than 140 degrees Fahrenheit, (2) <u>corrosive</u>, reacting gradually with other materials, (3) <u>reactive</u>, reacting and giving off either cyanide or sulfide gases, or (4) <u>toxic</u>, harmful to the health of plants, animals, and humans. The following list represents many of the products which become hazardous wastes in the typical home:

Table 1. Common Hazardous Household Products

pet flea collars	floor polish	toilet bowl cleaners
roach spray	slug bait	paint thinner
laundry soap	mildew proofing	weed killers
lacquer thinner	oil	wood preservatives
antifreeze	rat poison	brake fluid
no-pest strips	latex paint	mothballs
room deodorizers	disinfectant cleaners	oven cleaners
powdered bleaches	glass/window cleaners	scouring powder
batteries	drain openers	stains/varnishes
enamel paints	furniture polish	paint strippers

Activity 2. Review the list of hazardous household products above. Look in your own home and then circle those which are present there.

Comparing Solid Waste Generation

Industrial societies with smaller farming populations and higher incomes produce considerably more waste per person than do developing countries. New Yorkers, for example, discard nine times their weight of rubbish each year, while residents of Manila (Philippines) throw away 2.5 times their weight in rubbish. Part of the reason is that New Yorkers consume food from all over the world. The packaging required to keep this food fresh and attractive is much more than the amount of packaging used at farmers' markets in less developed countries. In addition, lower incomes in Third World countries encourage residents to conserve and reuse packaging material.

The following table compares refuse (waste) generation per person between several developed and less developed cities. This information can help you understand the difference between the amounts of solid waste produced in developed and developing countries.

Table 2. Refuse (Waste) Generation in Selected Cities, 1980

Industrial Cities (Developed Countries)	
New York, USA	1.80 kilograms/day/person *
Tokyo, Japan	1.38
Paris, France	1.10
Singapore	0.87
Hong Kong	0.85
Hamburg, West Germany	0.85
Rome, Italy	0.69
Low-Income Cities (Developing Countries)	
Lahore, Pakistan	0.60
Tunis, Tunisia	0.56
Bandung, Indonesia	0.55
Medellin, Colombia	0.54
Calcutta, India	0.51
Manila, Philippines	0.50
Kano, Nigeria	0.46

Source: *Worldwatch 76*, 1987.

* One Kilogram = 2.2 Pounds

Activity 3. Calculate the average amount of refuse produced per person per day for both the seven industrial cities and the seven low-income cities listed above in Table 2. (Note: one kilogram equals 2.2 pounds.)

Average Refuse/Person/Day:

Industrial Cities: _____ Low-Income Cities: _____

Why do you think a difference exists in the amounts of waste produced in industrial countries and in developing countries.

Why So Much Garbage?

Let's look at municipal solid waste in the United States. The U.S. represents the extreme instance of waste disposal problems and issues. The reason the United States faces a garbage glut is because many consumer goods are designed for one-way, one-time use. Almost every product an American consumer buys is wrapped, boxed, sealed, and/or bagged. From 1958-1971 packaging in the United States grew from 33 million tons to more than 66 million tons. In 1983 Americans used 92 billion metal cans, 42 billion glass bottles, and 16 billion plastic containers. In 1985 beer and soda bottles made up 60% of all discarded metal, glass, and plastic containers. The energy, materials, and environmental costs associated with this consumption pattern are enormous.

As America industrialized, the amount of disposable income increased. Consequently, the amount of money spent on goods, food, and beverages also increased. The attention of buyers focused on convenience, product storage, and package attractiveness. The American lifestyle was delivered by the "package" and packaging totalled about 180 pounds per American each year.

Increased packaging has resulted in a continually increasing amount of solid waste. There have also been costs. Approximately 10% of all food and beverage cost is for packaging. In 1986 that cost amounted to about twenty-eight billion dollars, increasing from $9.4 billion in 1973. The package disposal problem has recently worsened with the growing use of plastics.

Currently, there are several times more plastics produced (by weight) than all the aluminum and other nonferrous metals combined in the United States. Most people think of plastic as a single material. Actually, there are more than 46 different types of plastic, each with a special characteristic. A squeezable ketchup bottle, for example, is made of six different layers of plastic. Each layer is designed to do a different job such as provide shape, strength, or flexibility for the container. Combining plastics with other materials further expands the variety.

Plastics have compounded the waste disposal problem because most plastics do not readily break down over time. Also, most plastics are very difficult to recycle because of their variety. The use of plastic beverage containers has been growing astronomically. Fifteen million were used in 1967; 8.5 billion were used in 1982; 12.5 billion were used in 1985; and 20.0 billion are estimated for use in 1990.

Activity 4. Wrappers, Bags, and Boxes - A Closer Look!

Directions: Each student should bring to class an example of a food package. Students should then meet in small groups and examine and discuss each package with respect to the following questions and tasks. A group report will be prepared and submitted to the class on the group's most wasteful package and least wasteful package.

1. Describe the packaging, e.g, cardboard box, wax-coated paper, sealed plastic bag inside a cardboard box, etc.

2. How important are the components of the packaging system? For example, is the sealed bag inside the box important for some reason?

3. Why do you think the product is packaged in this manner? To protect the product? To protect health? To prevent theft? To provide advertising? To provide convenience? To promote purchasing? To make a product look larger or more appealing? To provide consumer information? Please explain your thinking:

4. Is the package system essential or wasteful? Why or why not? What reasons are you using to make your decision?

Essential _____; Wasteful _____. Explain:

5. What influence do you think this packaging has on this product's ability to sell? Explain.

6. What happens to the packaging for this product once the product is used?

7. Is the packaging recyclable? Biodegradable?

8. Is the packaging made from recycled materials? Renewable resources?

9. Would the packaging system be best described as (1) a "natural" packaging system like the skins of apples and bananas, (2) an "older" packaging system like paper bags and returnable bottles, or (3) a "modern" packaging system like plastic wrap, styrofoam, etc.?

1. "natural" _____; 2. "older" _____; 3. "modern" _____. Explain:

10. Are the "modern" packaging systems more effective than "older" packaging systems?

More Effective _____; Less Effective _____. Explain:

What Happens to Solid Waste?

Part I. Littering and Open Dumps

Discarding solid waste in open dumps is a typical disposal method in many developing countries. Open dumps have long been associated with rodents, insects, contaminated surface and groundwater, and fires. Thus, they pose serious health and aesthetic problems. Open dumping in many developed countries has been banned. The regulation of solid waste disposal has often led to illegal "midnight dumping", discarding wastes at unauthorized sites in rural or abandoned areas.

Littering refers to the random disposal of personal solid waste in an inappropriate, and probably illegal manner. Littering often leads to increased public costs for cleanup and disposal. It also leads to increased health and safety risks for both citizens and cleanup workers.

Part II. Sanitary Landfills

This type of disposal is designed to reduce the health-related and environmental risks associated with open dumps. Sanitary landfills usually consist of a deep pit or trough that has been lined with plastic to prevent ground water movement. Sanitary landfills overcome the problems of open dumps by spreading and compacting solid waste in successive layers. Each layer is separated by a barrier of soil. There is no burning, odor, insects or rodents, and little run-off if the landfill site was chosen to minimize water flow.

The floor of the landfill is sealed with a synthetic liner and drained with a pipe. The leachate (i.e., groundwater combined with liquid from the waste material) is tested regularly for water quality.

Decomposition of organic material in landfills often produces methane gas. A number of existing landfills recover methane. It is used as a source of natural gas piped to nearby homes or used to generate electricity. When filled, the landfill is capped with more soil and allowed to settle. Often, these sites are converted to parks, golf courses, or wildlife areas.

Problems with sanitary landfills include wind scattered litter, dust, heavy truck and machine noise, explosive methane gas, and contaminated groundwater. The biggest problem seems to be with contaminated groundwater. There is also a great deal of public opposition to landfills because of the belief that nearby property values will fall. And, as urbanization occurs, sites for future landfills become more difficult to find. This is especially true for highly populated urban regions.

Activity 5. What Happens To Our Garbage?

To The Teacher: Contact the owner of the local landfill, the owner of the waste collection service, or the community's maintenance supervisor and arrange for a field trip to help students determine the fate of solid waste in the community. If the field trip is not feasible, arrange for a guest speaker who is knowledgeable about local solid waste disposal. This activity should generate answers to the questions found below. A worksheet containing these questions can be constructed for students if desired.

1. Where is the garbage from your home and school taken?

2. How does it get there?

3. Why was the landfill located on this site? What factors must be considered when a site is selected? What tests were done at the site before it was opened? What were the results?

4. What laws govern solid waste disposal in your community?

5. Who owns the landfill? When did it open?

6. What is its life expectancy?

7. Who does the landfill site serve? Who can bring wastes to the landfill?

8. What is the fee for using the landfill?

9. How much does a household pay for trash collection?

10. How much solid waste is disposed of at this site daily, weekly and yearly?

11. Who works at the site? Who monitors what is dumped?

12. What happens to the trash once it is dumped at the site?

13. Are any of the materials hazardous? Are there regulations or procedures for dealing with hazardous wastes?

14. What is the land adjacent to the landfill used for? Is the landfill a problem for nearby landowners? If so, in what ways?

15. How is the site managed for the control of blowing trash, odors, noise, animals, erosion, surface runoff and leachate?

16. Have tests been performed regularly at the site (groundwater, soil, methane)? What were the results?

17. Is there a resource recovery program at the site? If so, what is recovered? How much?

18. How will the landfill be cared for after it is closed? Who will be responsible for its care? What will be done with the land at the site?

19. What alternatives for waste disposal has your community considered for the future?

Part III. Solid Waste Incineration

As landfills close and the volume of solid waste continues to grow, there is a greater emphasis on incineration. Currently, in the United States there are 70 waste incinerators accounting for about 7% of the solid waste disposed of in 1986. In Columbus, Ohio a $200 million incinerator burns 2000 tons of waste a day and produces electricity. Across the world there are more than 350 incineration plants located in western Europe, Japan, Brazil, and the U.S.S.R.

Incinerators burn combustible solid waste at high temperatures. This reduces the volume of the waste by 80-90%. The ash-like residue is then deposited in a landfill. Because the residue takes up much less space than the original solid waste, the life of the landfill can be extended. Incineration also kills disease organisms and permits the separation of recyclable products such as metal and glass. The heat from combustion can also be used to generate electricity. In fact, a number of countries rely on waste combustion as an important source of electricity. In West Germany, 34% of its electricity comes from the incineration of solid waste. In Sweden, 51% comes from incineration; in Japan, 64%; and in Switzerland, 75%.

However, there are environmental problems associated with waste incinerators. Some experts believe that the incineration of products containing chlorine (plastics, table salt, and bleached paper) form cancer-producing compounds. For this reason there is often citizen opposition to an incinerator. At this point in time emissions standards for incinerators have not been adopted in the United States. Sweden's extensive waste incineration program is currently on hold pending further tests on air quality. Some European countries and the United States have proposed using ocean-going incineration vessels. These are supposed to separate the air pollutants generated by incineration from populations of people.

Air pollution is not the only problem. Incinerator ash is sometimes classified as hazardous and, as a result, that ash is banned from disposal in landfills. Incinerators are also costly to build and expensive to operate and maintain.

Part IV. Resource Recovery: Recycling

The solid waste discarded in all nations contains valuable metals, paper representing millions of forest trees, and plastics containing highly refined petrochemicals. Only about 25% of the metals and papers used in the world is recycled. In the United States only about 8% of the glass, metals, and paper is recycled. Recycling reduces the amount of solid waste that must be buried or incinerated. It also promotes a number of other environmental benefits associated with energy, air and water. The following table summarizes the environmental benefits of recycling resources.

Table 3. The Environmental Benefits of Using Recycled Resources

Benefit	Aluminum	Steel	Paper	Glass
Reduction of:	%	%	%	%
Energy Needed	90-97	47-74	23-74	4-32
Air Pollution	95	85	74	20
Water Pollution	97	76	35	___
Mining Wastes	___	97	___	80
Water Use	___	40	58	50

Source: *Worldwatch Paper 76*, 1987

The information above indicates that recycling has advantages over both landfilling and incinerating solid waste. Landfilling does not conserve recyclable resources or energy. Incineration does not conserve resources but the energy generated by incineration can reduce the need for fossil fuels. Recycling conserves both resources and energy, and also reduces the need for landfills.

Individuals and societies vary widely with respect to recycling behavior. The following table shows the percentages of aluminum, paper, and glass recycled in a number of countries.

Table 4. Recovery Rates for Aluminum, Paper, and Glass (% Recovered)

Country	Aluminum	Paper	Glass
Netherlands	40	46	53
Italy	36	30	25
West Germany	34	40	39
Japan	32	51	17
United States	28	27	10
France	25	34	26
United Kingdom	23	29	12
Austria	22	44	38
Switzerland	21	43	46
Sweden	18	42	20

Source: *Worldwatch Paper 76*, 1987

Recycling is cost effective according to experts. Studies in New York, Pennsylvania, and California indicate that the cost for incineration averages about $50 per ton while the cost for a recycling program for the same wastes averages about $25 per ton. Recycling also creates more jobs than other waste disposal methods. About 36 jobs are created for every 10,000 tons of material processed, compared with six jobs for landfilling and about one for incineration.

Activity 6. Identifying Recyclable Materials

Directions: The purpose of this activity to classify solid waste into four categories on a basis of the materials from which it is composed. Wastes might be . . .

A. **organic** - Naturally-occurring raw materials derived from living things which will decompose (biodegrade) naturally into simpler materials, e.g., food and yard wastes can be composted.

B. **renewable/recyclable** - naturally occurring raw materials derived from a cyclical source such as trees, fish, drinking water, etc. These resources can be replaced with careful management.

C. **nonrenewable/recyclable** - naturally occurring raw materials which are limited in supply and exhaustible and which can be recycled, e.g., motor oil, steel, aluminum.

D. **nonrenewable/hard to recycle** - naturally occurring raw materials which are limited in supply and exhaustible but which are very difficult to recycle, e.g., plastic toothpaste tubes, plastic toothbrushes, plastic milk cartons.

Examine the products listed below and decide which resource classification category is appropriate for each. For resource classification, write A, B, C, or D. (Do nothing with the Disposal Method column at this time.)

Waste Item	Resource Classification	Disposal Method
paper bag		
newspaper		
book		
paper milk carton		
aluminum can		
apple core		
old clothes		
tin can		
glass jar		

potato peels	_____	_____
broken toy	_____	_____
rat poison	_____	_____
grass clippings	_____	_____
other: _____	_____	_____
other: _____	_____	_____

More Information: There are four basic ways to dispose of waste:

1. **reuse** - reusing the waste for another purpose or, after repair, for the original purpose, e.g., highway concrete can be used to prevent shore erosion along rivers and lakes.

2. **recycle** - recovering the waste's raw materials which are then re-manufactured into the same or different product, e.g., recycled plastic can be used to make insulated fill for winter jackets.

3. **recover energy** - burning the waste in an incinerator to generate electricity or steam.

4. **landfill** - burying the waste in a sanitary landfill.

More Directions: Refer to the products listed above and decide which is the best way to dispose of each trash item. Write your choice (1, 2, 3, or 4) in the Disposal Method column provided. After that is done answer the questions below.

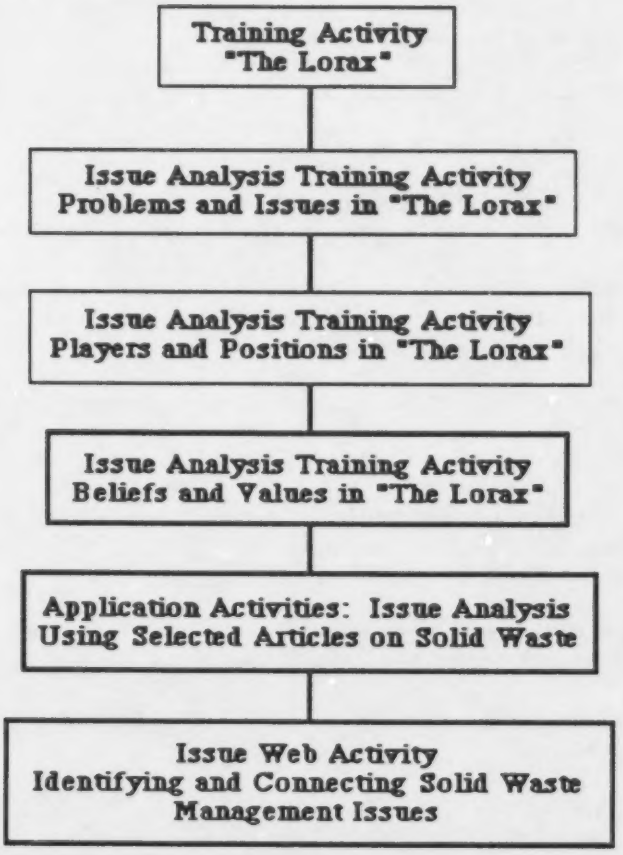
1. To what extent is there a difference between the disposal methods you selected and the actual disposal method that is typically used by most citizens in your community?

2. What could you do to encourage your family, school, and community to recycle and reuse more waste products?

3. How does a person recycle in your community? Make a list of the who/what/when/where information concerning recycling.

SCHEMATIC OF ACTIVITIES FOR GOAL LEVEL II: ISSUE AWARENESS

SEQUENCE


Training Activity
"The Lorax"
Issue Analysis Training Activity
Problems and Issues in "The Lorax"
Issue Analysis Training Activity
Players and Positions in "The Lorax"
Issue Analysis Training Activity
Beliefs and Values in "The Lorax"
Application Activities: Issue Analysis
Using Selected Articles on Solid Waste
Issue Web Activity
Identifying and Connecting Solid Waste
Management Issues

Included in Document

Not Included in Document

LEVEL II: ISSUE AWARENESS

To the reader:

Level II uses the background information found in Level I to focus on issue analysis. Initially, students are trained to analyze issues in order to isolate the "players", the players' positions/beliefs, and their values. The vehicle used for issue analysis training is *The Lorax*, a famous children's' story by T.S. Geisel (Random House, New York). Students are subsequently involved in the analysis of the solid waste issue itself and a variety of other activities related to issue awareness. Level II activities are prerequisite to the actual investigation of the solid waste issue (Level III) and also to citizenship behaviors regarding that issue (Level IV).

Space restrictions preclude including all the activities used in training students in the skills associated with issue analysis. Thus, Level II (in this document) begins with minimal training activities and focuses primarily on activities that require students to apply those skills.

Beliefs and Values

The following terms and their definitions have been introduced.

Problem: A situation or condition in which something or someone is at risk or threatened.

Issue: A problem about which two or more people or groups of people disagree.

Player: Those person(s) or group(s) who have a role in an issue or its solution.

Position: The stand or posture taken by the player in regard to the issue or its solution.

Issues are complex. Those ideas presented above are probably not sufficient for one to completely understand an environmental issue. In this lesson two more ideas are presented which, once learned, will complete the set of skills required for environmental issue analysis. Those new ideas are **beliefs** and **values**. Both beliefs and values are related to a player's position on the issue.

A **belief** is an idea that a person holds. The person thinks/believes that idea is true. In reality, it might or might not be. Often a person's beliefs are strongly related to his or her values. Values are specific ideas which help an individual decide what is important or worthy. A **value** is the comparative worth a person places on something. Each individual has personal values which develop in response to past experiences. These values might involve money, status, beauty, or a number of other characteristics. A partial list of values and their descriptions entitled "Value Descriptors" can be found on the following page.

VALUE DESCRIPTORS

The following descriptions attempt to name and define specific values that might be held by individuals. This is only a partial list. There are many kinds of values.

Aesthetic:	the appreciation of form, composition, color or sound through the senses.
Cultural:	pertaining to the continuation/preservation of human knowledge, beliefs, values, art, customs, etc.
Ecological:	the maintenance of the integrity of natural living systems.
Economic:	the use and exchange of money and materials.
Educational:	concerning the accumulation, use, and communication of knowledge.
Egocentric:	pertaining to a focus on the individual; personal self-satisfaction and fulfillment.
Ethical/Moral:	pertaining to present and future responsibilities, rights and wrongs, and ethical standards.
Health:	the maintenance of positive human physiological conditions.
Legal:	pertaining to laws, rules, and regulations; the making of, respect for, and enforcement of laws.
Political:	the activities, functions, and policies of governments and their agents.
Recreational:	pertaining to leisure activities.
Religious:	the use of belief systems based on faith; dogma.
Scientific:	concerning those attributes associated with empiricism and empirical research.
Social:	pertaining to shared human empathy, feelings, and status; an interaction of humans.

How do values influence beliefs? How do beliefs influence positions on issues? Values provide the guide-posts for individuals to determine what is important to them. Thus, values help shape the beliefs that an individual holds on an issue, and they help determine that individual's position on that issue. For instance, the poachers, who kill black rhinos for their horns, value the money they receive more than they value the stability of the rhino population. That is, an economic value is more important than an ecological value for the poachers. On the other hand, many wildlife experts have different value emphases.

They believe that the preservation of the species is more important than the monetary gain of a few individuals.

A skilled observer can identify a player's values by carefully listening and analyzing the player's belief statements. For example, consider the following two statements about recycling.

A. "I recycle soda cans because I am really annoyed by all the unsightly litter on streets and highways."

B. "It's easier for me to just pitch soda cans out the car window. Let someone else pick them up!"

Statement A reflects an **aesthetic value** because the individual is concerned about the physical appearance of the environment. Statement B reflects an **egocentric value** because the individual is concerned solely about his/her personal comfort and convenience. Analyzing what players say and do allows one to determine what values the players are using to make decisions in an environmental issue. Issues arise because different people have different ideas about what is important.

Let's practice identifying the values indicated by a player's beliefs statements. Again, let's return to *The Lorax*. On the following worksheet statements made by the Once-ler and the Lorax have been supplied. Your task is to identify the value indicated by each statement. You may refer to the "Value Descriptors" worksheet for assistance.

BELIEF STATEMENTS IN *THE LORAX*

For the reader:
Although the activity that follows is based on *The Lorax* which is not presented in this appendix, the items in this activity are fairly straightforward. Therefore, the "value positions" should be identifiable even though *The Lorax* has been omitted.

Directions: Each statement below suggests the speaker's values, the characters' ideas about what is important or worthy. Use the "Value Descriptors" list as a guide. Remember, there are no absolutely right or wrong answers. Your answer is a "good answer" if you can successfully defend it.

BELIEF STATEMENTS	VALUE POSITION
What the Once-ler said	
1. "But . . . . business is business! And business must grow . . . "	_____
2. "And I biggered my money, which everyone needs."	_____
3. "Plant a new Truffula. Treat it with care. Give it clean water. And feed it fresh air."	_____

4. "Well, I have my rights, Sir, and I'm telling you
I intend to go on doing just what I do !" _____

What the Lorax said . . . .

5. "You're gumming the pond
where the Humming-Fish hummed!" _____

6. "No one can sing who has smog in his throat." _____

7. "Sir, you're crazy with greed.
There is no one on Earth
who will buy that fool thneed!" _____

A. What appears to be the value(s) influencing the Once-ler's statements?

B. What appears to be the value(s) influencing the Lorax's statements?

Identifying Solid Waste Management Problems and Issues in Secondary Source Literature

To the reader:

At this point in Level II, students are asked to read one or more carefully selected articles on solid waste management and then identify and communicate the "problems" and "issues" stated in or inferred by the article(s). They are also asked to complete an "Issue Analysis" based on their reading(s). A few examples of articles that might be selected follow:

Budiansky, Stephen, "Tons and Tons of Trash and No Place to Put It", *U. S. News and World Report*, Dec. 14, 1987, 58-62.

Church, G. J., "Garbage, Garbage, Everywhere", *Time*, Sept. 5, 1988, 81-82.

Lauren, Bill, "Getting Into a Heap of Trouble", *National Wildlife*, Aug./Sept., 1988. 19-24.

Mann, Carolyn, "Garbage In, Garbage Out", *Sierra*, Sept./Oct., 1987, 22-27.

Marbach, W. D. "What To Do With Our Waste", *Newsweek*, June 27, 1987, 51-52.

Steinhart, Peter, "Down in the Dumps", *Audubon*, May 1986, 103-109.

Directions: You are asked to read and analyze one or more selected articles concerning a specific solid waste management topic. Your tasks will be to: (A) identify the critical problems associated with that solid waste topic, (B) identify the issues associated with that

solid waste topic, and (C) complete an "Issue Analysis" of a specific solid waste issue. The Issue Analysis will consist of determining the players, their positions, beliefs, and values associated with that specific issue. The worksheet provided below should be used for determining the problems and issues. The accompanying worksheet should be used for Issue Analysis. Further, you might be asked to repeat this process by reading additional articles which focus at other solid waste topics.

Write a bibliographic citation for the periodical article(s) to be examined.

_____

_____

_____

A. What are the critical problems described in or inferred in your reading(s)? (Remember that problems occur when the status of something or someone is at risk or threatened.)

B. What are the critical issues identified in or inferred by your reading(s)? (Remember that issues occur when two or more people or groups of people disagree about the problem or its solution.)

ISSUE ANALYSIS WORK SHEET

THE ISSUE:

THE PLAYERS AND THEIR POSITIONS	THE PLAYERS' BELIEFS	THE VALUE

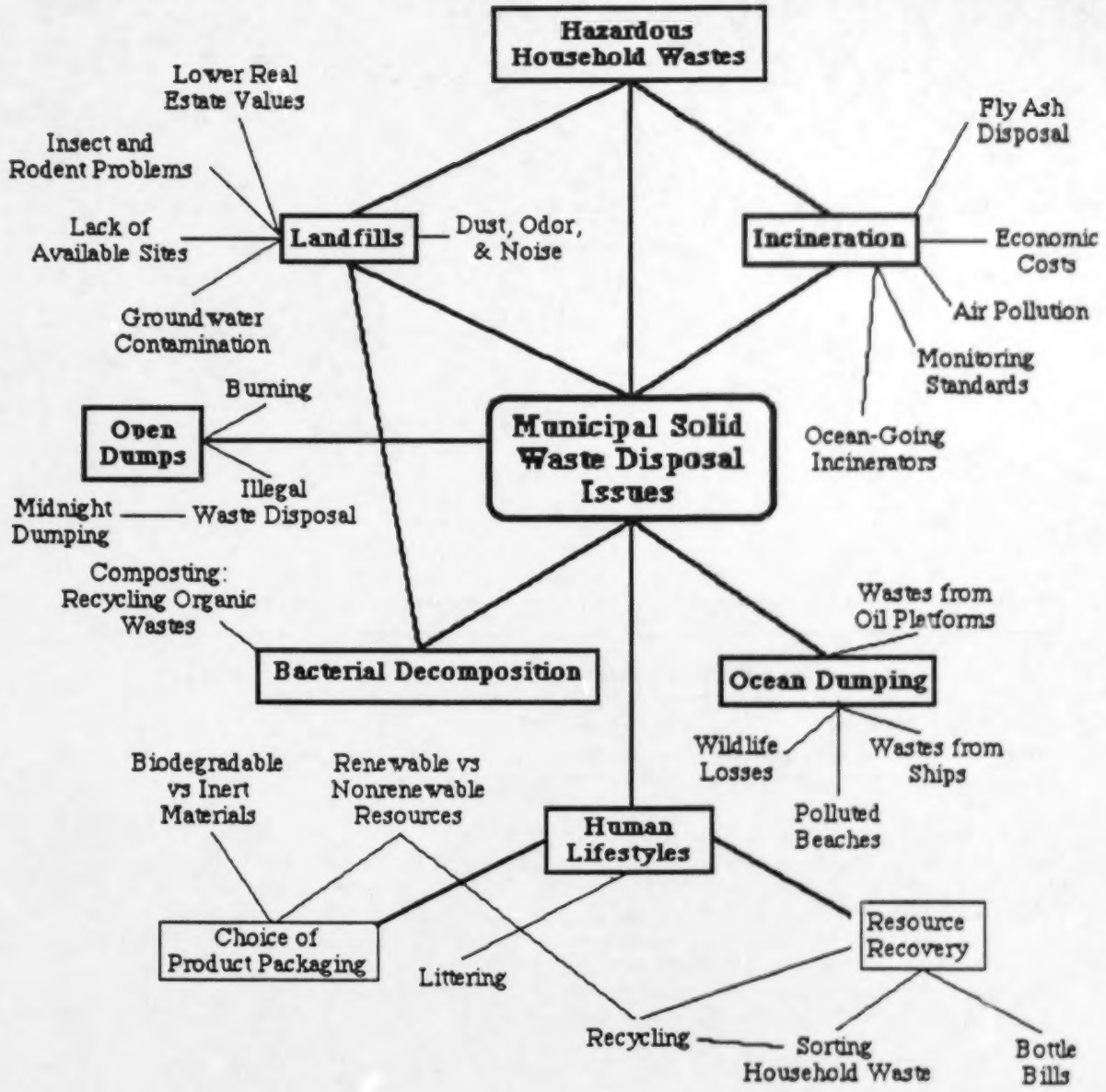
Developing an Issue Web

Once students are familiar with numerous issues surrounding solid waste management, they should have an opportunity to synthesize that knowledge through the development of an "issue web". This activity involves diagramming the spectrum of solid waste issues in a way that ties them together in a meaningful manner. And, since many issues are related to each other, the issue web allows this to be done in a relatively simple manner.

Students can be given large sheets of paper or newsprint, or this activity can be done on a chalk board. The words "Solid Waste Management Issues" should be printed in the center of the paper/newsprint/chalkboard. Students are then assigned the task of placing major sub-issues around the perimeter of the paper, e.g., open dumping, ocean dumping, incineration, hazardous wastes, etc. Once this is done, students can surround the sub-issues with the "minor" issues associated with them. Then, these issues can be tied together by lines (where appropriate). It will become obvious that "Solid Waste Management Issues" are very complex and interrelated.

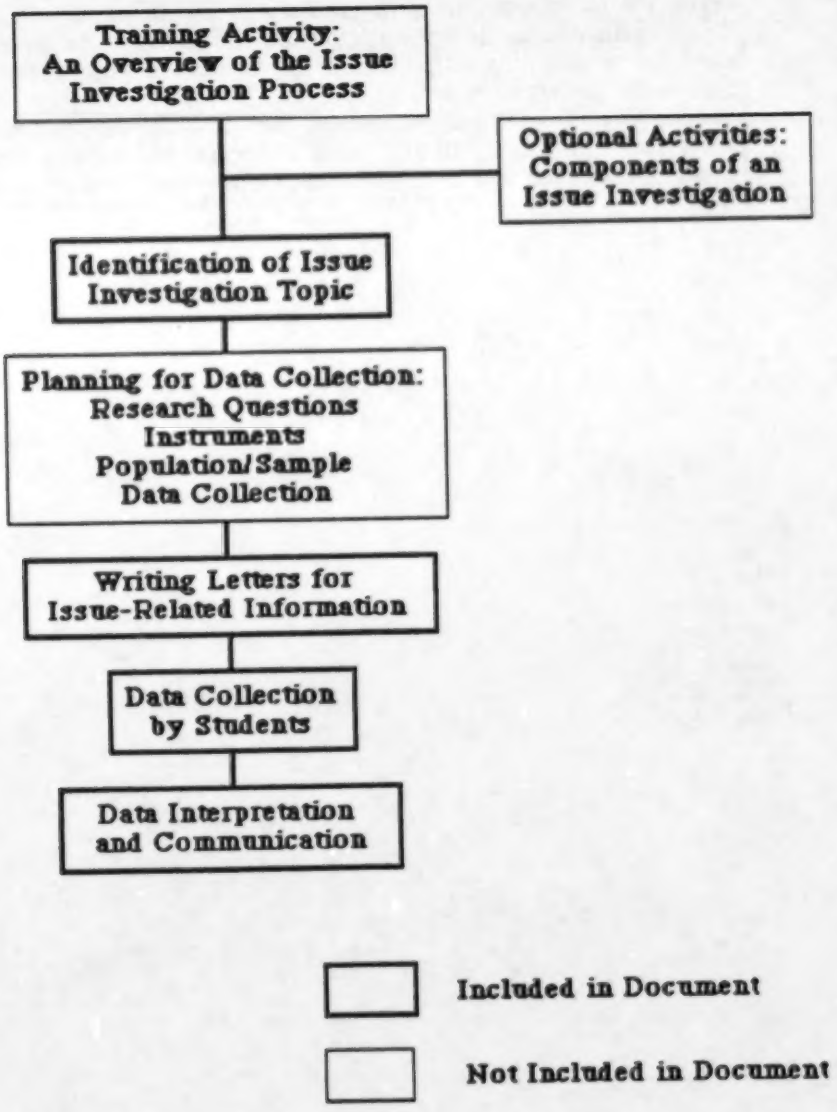
A sample solid waste issue web is presented on the next page as an example.

An Issue Web:
Municipal Solid Waste



SCHEMATIC OF ACTIVITIES FOR GOAL LEVEL III

SEQUENCE


Training Activity: An Overview of the Issue Investigation Process
Optional Activities: Components of an Issue Investigation
Identification of Issue Investigation Topic
Planning for Data Collection: Research Questions Instruments Population/Sample Data Collection
Writing Letters for Issue-Related Information
Data Collection by Students
Data Interpretation and Communication
Included in Document
Not Included in Document

LEVEL III: ISSUE INVESTIGATION

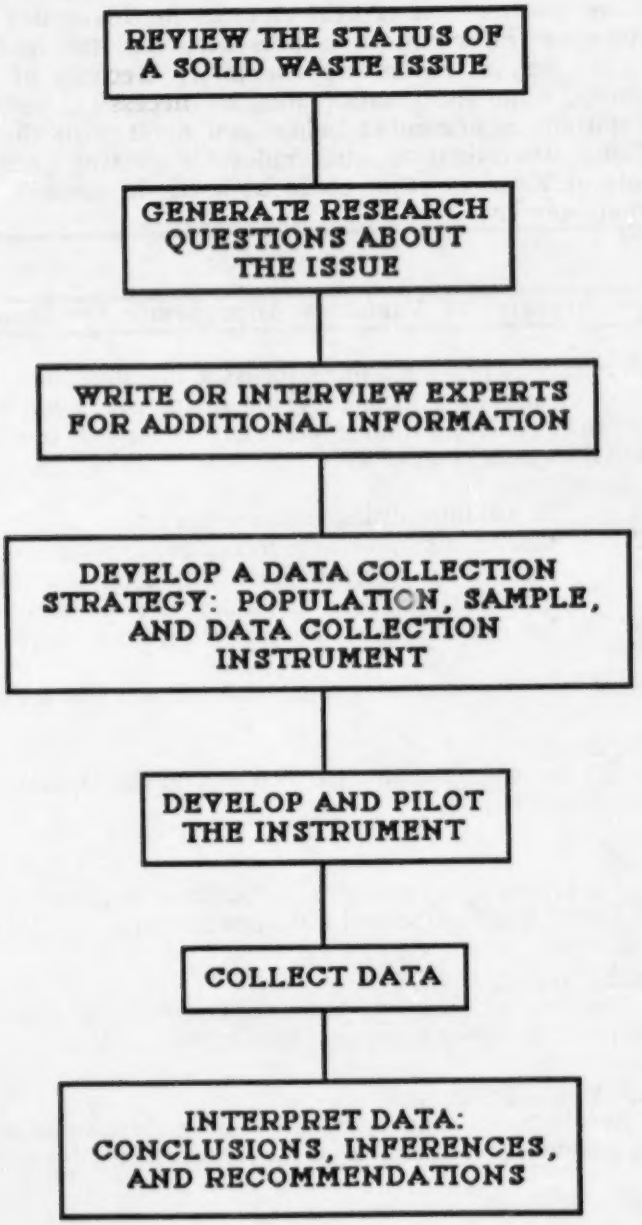
To the reader:

Level III focuses on involving students in investigations into a local or regional solid waste issue. Typically, Level III activities involve identifying specific problems to investigate, writing or interviewing expert sources for additional information, formulating research questions needing answers, designing and conducting surveys construc'ed to answer the research questions, and interpreting the information collected.

The reader is reminded that the case study presented here is abbreviated from the original. However, several of the components are kept intact and will be presented here.

The flowchart found on the next page is designed to give an overview for Level III. It has been designed so that it can be used as an overhead for projection or reproduced for distribution to the students.

INVESTIGATING A SOLID WASTE ISSUE USING SURVEYS, QUESTIONNAIRES, OR OPINIONNAIRES


REVIEW THE STATUS OF A SOLID WASTE ISSUE
GENERATE RESEARCH QUESTIONS ABOUT THE ISSUE
WRITE OR INTERVIEW EXPERTS FOR ADDITIONAL INFORMATION
DEVELOP A DATA COLLECTION STRATEGY: POPULATION, SAMPLE, AND DATA COLLECTION INSTRUMENT
DEVELOP AND PILOT THE INSTRUMENT
COLLECT DATA
INTERPRET DATA: CONCLUSIONS, INFERENCES, AND RECOMMENDATIONS

To the reader:

Again, Level III is designed to assist students in an actual issue investigation. Certain key elements must be covered in order to accomplish this in a scientific manner. The flowchart seen earlier attempts to show how these elements are organized in order to make Level III successful. In a case study, the teacher is a critical element in this entire process.

The following information is presented for the teacher, to be used with learners as he/she deems appropriate. Because of the abbreviated format used here, some information has, by necessity, been omitted. However, critical content is presented below and deals with the identification of variables in issue investigation, the rules for writing research questions, and an example of a survey that could be used in some nations regarding solid waste management.

Identifying Categories of Variables Appropriate for Issue Investigation

Research questions provide a focus for issue investigation. In general, research questions include the variables associated with the issue which will be investigated. Research questions can be generated from several categories (types) of variables. These categories include variables associated with . . .

1. . . . factual information related to the issue.
2. . . . individuals' knowledge related to the issue.
3. . . . individuals' perceived knowledge about the issue.
4. . . . individuals' attitudes about the issue and its solution.
5. . . . individuals' behavior associated with the issue.

Examples of variables concerning solid waste management in each category follow:

Factual Information:

- The number of landfills and their average life expectancy within a prescribed region.

Knowledge:

- The knowledge of residents in a particular region concerning the dangers to human health associated with open dumping.

Perceived Knowledge:

- Middle school students' perceived knowledge of solid waste disposal methods and the environmental implications of each.

Attitudes (can include opinions):

- Residents' opinions concerning proposed legislation which would mandate the sorting and recycling of residential solid wastes.

Behavior:

- The recycling practices of the residents of a given neighborhood, village, or city.

Guidelines for Research Questions

Research questions dictate what is investigated and, to a great extent, how it is investigated. This makes the wording of those questions extremely important. Therefore, certain guidelines should be followed in the construction of the research question(s) used in an investigation. The research question should permit the investigator to look into variables that are truly important and, also, to answer the question in a manner that respects the intent of the investigation.

For example, let us look at two research questions and analyze their difference(s):

1. Do residents of _____(neighborhood or city)_____ have strong negative opinions about proposed legislation that would demand that solid wastes be sorted in residential neighborhoods prior to collection?

2. To what extent do residents of _____(neighborhood or city)_____ agree with the intent of proposed legislation that would demand that solid wastes be sorted in residential neighborhoods prior to collection?

These two research questions focus on the same legislation concerning solid waste and the same populations. However, this is the extent of their similarities. Question No. 1 demands a "yes" or "no" response. It also deals with "negative opinions" only. Thus, Question No. 1 is very limiting for the investigator. Question No. 2, on the other hand, does not demand a "yes" or "no" response and it permits the investigator to inspect opinions across the entire spectrum of opinions - extremely negative to extremely positive. The latter question is much better than No. 1.

What are the guidelines that should be followed in the preparation of research questions? Research questions should . . .

1. . . . be stated in question form.
2. . . . avoid "yes" or "no" responses.
3. . . . be important in an environmental sense.
4. . . . specify a relationship between variables.
5. . . . indicate a population or a geographic area (or both).

Examples of appropriate research questions

1. To what extent are residents of _____(town or region)_____ aware of the health dangers associated with open dumping?
2. To what extent does ocean dumping result in the contamination of beaches along the Gulf of Mexico?
3. How much aluminum (by weight) is discarded each year by residents of _____(neighborhood or village)_____?
4. To what extent do the residents of Jackson Township support the development of a new landfill in their township?
5. What are the economic costs related to the cleanup of litter along highways and roads in the counties of western Kentucky?
6. To what extent are the adults in _____(region/country)_____ aware of the benefits of composting organic wastes?

Organizations Associated With The Problems and Issues Of Solid Waste Management

The purpose of the activities at this level is to ask appropriate questions about solid waste management and find their answers. One method to accomplish this is to write letters requesting specific information of experts as well as resource persons and organizations . The sample letter on the following page is a model of a request for information to answer a specific question. The list of organizations below represents those national organizations which might have answers to the questions you have asked. Addresses for state-level agencies and organizations have not been provided, but they should be considered as important additional sources of information.

The Aluminum Association, 818 Connecticut Ave. NW, Washington, DC, 20006.

American Paper Institute, 260 Madison Ave., New York, NY, 10016.

Environmental Defense Fund, 1616 P St. NW, Washington, DC, 20036.

Environmental Task Force, 1346 Connecticut Ave. NW, Suite 912, Washington, DC 20036.

Glass Packaging Institute, 1133 20th St. NW, Room 321, Washington, DC 20036.

Institute of Scrap Recycling Industries, 1627 K St. NW, Washington, DC 20006.

National Recycling Coalition, 28-29 41st Ave., 5th Floor, Long Island City, NY 11101.

National Solid Waste Management Association, 1120 Connecticut Ave. NW, Washington, DC 20005.

The New Alchemy Institute, 237 Hatchville Road, East Falmouth, MA 02536.

Resources for the Future, 1616 P St. NW, Washington, DC 20036.

The Society of the Plastics Industry, 1275 K St., Suite 400, Washington, DC 20005.

U.S. Environmental Protection Agency, 410 M St. SW, Washington, DC 20460

Sample Letter

Director
Office Of Solid Waste Management
U.S. Environmental Protection Agency
401 M St. SW
Washington, DC 20460

Dear Director:

As part of a study of solid waste management, our class recently read an article entitled "Landfill Fact Sheet", published by Sonoco, Inc., 1987. In this article (page 1) the following statements were made:

1. "Even though 67% of landfill waste is biodegradable, the EPA states that there have been no real signs of significant degradation to extend the useful life of landfills."

2. "Paper is not readily biodegradable in landfills because most landfills are poorly constructed."

3. "Substituting paper sacks for plastic sacks in landfills would shorten the life of landfills because paper consumes six times the space of plastic."

These statements raised additional questions about waste, landfills, and biodegradability. As a national expert in the area of solid waste management, you are asked to help answer several questions. We would appreciate your responses to the following questions:

1. How does the design of sanitary landfills inhibit the disintegration of biodegradable solid waste?

2. How should landfills be constructed in order to promote the disintegration of paper, a biodegradable material?

3. What percent of United States sanitary landfills conform to EPA-approved designs?

Thank you for your help in providing answers to these questions.

Sincerely,

The Investigation

To the reader:

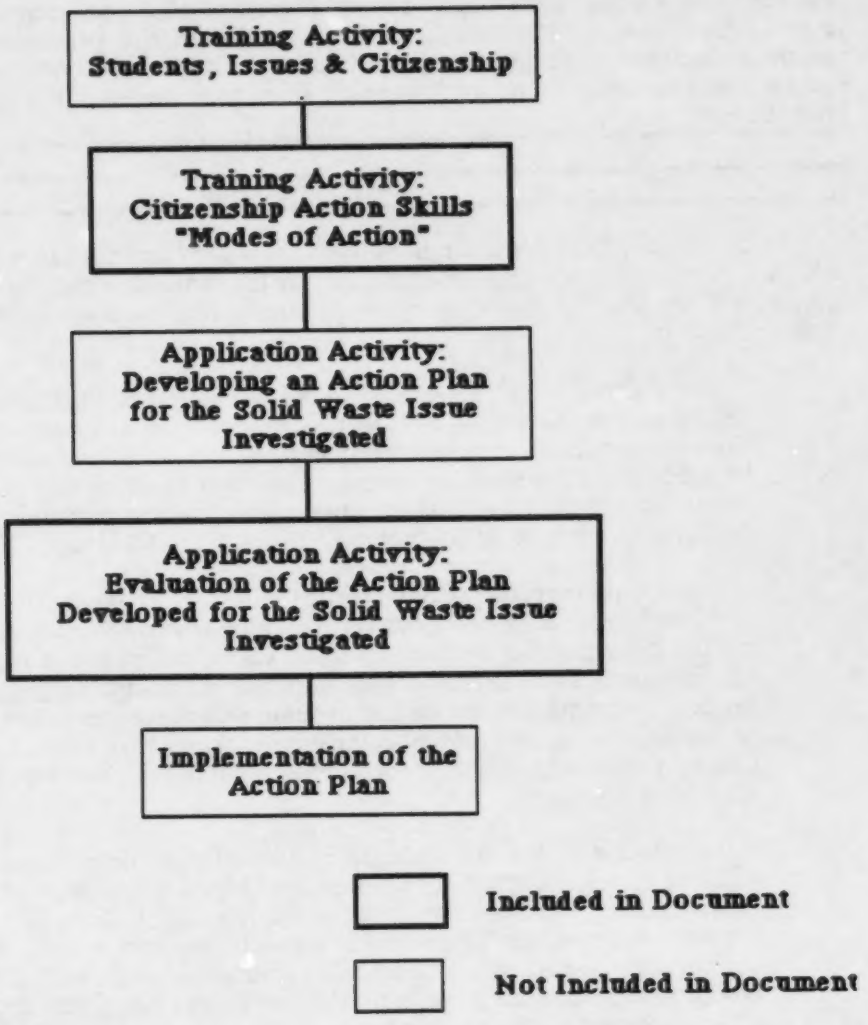
Teachers may choose to have students identify an issue to investigate and to learn and apply the skills involved in writing research questions. This is recommended. It can, perhaps, best be accomplished by having students work in small groups, reporting back to the entire class. Subsequently, the entire class may make a decision as to the issue to be investigated and the research questions to be used.

Or, the teacher, having developed a highly structured case study, may choose to present a suitable research question complete with an instrument that will "answer" that research question. Either way, it is very important for the students to have the experience of conducting an actual investigation and interpreting the data (answering the research question) subsequently.

An example of a questionnaire, focused on individual behaviors relative to the use and disposal of glass and metal containers, is included in Appendix III. This example also includes a data collection sheet. Both may be used or adapted for use by the teacher. However, this is only an example and this instrument may not be suitable for many circumstances or world regions. Regardless, it is very important for any instrument to be carefully constructed and designed specifically to answer the research question(s).

SCHEMATIC OF ACTIVITIES FOR GOAL LEVEL IV: CITIZENSHIP ACTION

SEQUENCE



LEVEL IV: CITIZENSHIP ACTION

To the reader:

Level IV involves students in the selection of an appropriate citizenship action for helping to resolve the issue they have investigated. The case study should introduce students to the various modes of action which are appropriate to citizenship action. The most appropriate mode is selected and a specific action chosen. The format for the selection of the specific action is rather structured to make certain that the action selected is an appropriate one. Once students have evaluated the proposed action(s) and made a decision about its appropriateness, it is recommended that they be given the encouragement and support necessary to enable them to complete the action.

Modes of Action

In general, there are a number of ways in which citizens can work to bring about solutions to environmental issues. If we analyze the available strategies for taking citizenship action, we find that they can be grouped under four headings for middle school students. Those are:

Persuasion: Persuasion is used when an individual or a group of people tries to convince others that a certain action is correct. Examples: Convincing a friend to recycle aluminum, writing an environmental letter to be published in the local newspaper, making and putting up posters urging people to recycle used food containers, convincing parents to purchase foods which come in environmentally-appropriate packaging.

Consumerism: Consumerism relies on the power of money. It involves buying something that agrees with one's environmental values or not buying something that represents an action or idea one disagrees with. Consumerism is actually a specialized form of persuasion. Examples: Buying only soft drinks which are packaged in recyclable containers, refusing to purchase products made by companies with negative environmental records, purchasing prepared food from vendors who use a minimum of packaging.

Political Action: Political action refers to bringing pressure on political or governmental agencies and/or individuals in order to persuade them to take positive environmental action. Examples: Writing a legislator supporting the passage of an environmentally-appropriate law, campaigning for a candidate with a good environmental record, voting for a pro-environmental candidate, appearing before a city council and requesting a recycling center for the community.

Ecomanagement: Ecomanagement is a physical action taken with respect to the environment. Hopefully, it results in either maintaining or improving environmental quality. Examples: Picking up beach debris from ocean dumping, recycling materials such as aluminum and steel, composting organic matter such as leaves and vegetable wastes.

Selecting and Evaluating Actions

To the reader:

The "Solution Analysis Worksheet" is designed to help students consider alternative solutions and their implications. It asks students to propose a solution and look at a number of consequences of that solution. This activity is followed by a second worksheet which asks students to select a specific action for implementation. And, finally, students are asked to answer a number of questions about that action on what is called the "Action Analysis Criteria Worksheet".

Why should there be three worksheets for selecting an action? It is crucial that students carefully consider solutions in a general sense before choosing a specific action that they think would work. It is entirely possible that, in some cases, the action is chosen without due regard for a number of possible complications. Therefore, students are asked to "filter" their decision through a variety of questions which are designed to help them evaluate their decision. The writers recommend the use of three worksheets to accomplish these important tasks.

The Solution Analysis Worksheet

What is the solid waste issue under consideration?

_____

What is the proposed solution for this issue?

_____

Part I. Identify the consequences of the proposed solution in each of the following categories. Try to think of all of the consequences, both negative and positive.

Ecological Consequences:

Political/Legal Consequences:

Social Consequences:

Economic Consequences:

Other Consequences (e.g., educational, recreational, etc.):

Part II. The consequences you have identified represent the trade-offs involved in this particular solution for the issue. As you might be able to see, some consequences might be considered "losses" (negative effects) while others might be considered "benefits" (positive effects). Examine all the consequences you have identified, and then summarize the most important "benefits" and "losses" below.

Important Benefits	Important Losses

Appendix III

Selected Activities From:

Issue Investigation and Citizenship Action Training

Sample Activities for Year Three

Reference: Chapter III; Year III

**Portions of Part II C; Part IV A, B, C, D. F.;
Part VI; Part VII B, C, F**

Appendix III

NOTE: The following activities serve as models for middle school curriculum developers in the field of environmental education (see Year III of "The Three Year Curriculum: A Detailed Outline", Chapter III). These activities do not contain all of the content found in the Chapter III outline since space does permit the full development of that year-long curriculum. These activities are taken from Investigating and Evaluating Environmental Issues and Actions: Skill Development Modules (1988) and reprinted here by permission of Stipes Publishing Company, 10 Chester Street, Champaign, Illinois (USA) 61820.

Contents:

Research Question Rules

Writing and Evaluating Research Questions

Questionnaires

Basics of Sampling

Interviews

A Planning Sequence for Surveys, Questionnaires, or Opinionnaires

An Issue Investigation Assignment: Model and Flow Chart

Important Ideas About Action

The Methods of Action

Developing an Issue Action Plan

The Action Selection Worksheet

A. What is the solid waste issue under consideration?

B. Summarize what you found out during your investigation of this issue.

C. What solution do you propose for helping solve this issue?

D. Is this solution consistent with the findings from your investigation?

E. What citizen actions could be used in this solution?

F. What specific action(s) are you considering?

The Action Analysis Criteria Worksheet

What is the specific action you are analyzing here?

A. Is there sufficient evidence to warrant the use of this action?

B. Is this action the most effective one available?

C. What are the legal consequences of this action?

D. What are the social consequences of this action?

E. What are the economic consequences of this action?

F. Do my beliefs and values support the use of this action?

G. Do I understand the beliefs and values of others involved in this issue?

H. Do I understand the procedures necessary to take this action?

I. Do I have the skills needed to take this action?

J. Do I have the courage to take this action?

K. Do I have the time needed to take this action?

L. Do I have all of the other resources needed to make this action effective?

M. What are the ecological consequences of this action?

FINAL DECISION: After analysis, is this action the one you would now choose to take?

Yes _____ No _____. Why or why not?

Research Question Rules

There are several important rules for writing research questions for environmental issue investigations. These research questions ...

1. ...are always **stated in question form**.

2. ...always **avoid simple "yes" or "no" responses.** This is usually achieved by beginning with phrases such as "To what extent" and "In what ways".

3. ...always **indicate a population or area.** The population refers to a group on which the research question is focused, e.g., Pennsylvania hunters, wildlife biologists, etc. The area refers to the geographic area in which the data will be collected, e.g., midwestern states, Randolph County, Dewey Elementary School, etc.

4. ...are always **derived from and related to environmental issues.**

5. ...when possible, **specify the variables to be measured.** A variable is a given factor or condition, e.g., knowledge of ecology, attitudes toward poaching, size of the deer population , etc. The following research question specifies the variable to be measured: What are Illinois deer hunters' attitudes toward the harvesting of female deer?

6. ...when possible, **specify a relationship between two variables.** The following question seeks to find the extent that one variable (knowledge of ecology) affects another variable (attitudes about deer harvesting): To what extent does ecological knowledge affect Illinois deer hunters' attitudes toward the harvesting of female deer?

7. ...are **important in an environmental and social sense**. Issues dealing with endangered species, toxic waste disposal, feral animal populations, deforestation of rain forests, contamination of ground water supplies, wilderness preservation, and the integrity of national park ecosystems are examples of issues which have implications for humans as well as for the environment.

The authors realize that writing good research questions takes a lot of practice. Another environmental issue situation will be presented for you. This one involves whooping cranes. Your task will be to analyze the information in such a way that you can write good research questions.

Whooping Cranes

A young whooping crane recently died from lead poisoning. Only two wild flocks of these birds are still in existence. This young crane was one of twenty-nine whoopers which winter at the Bosque Del Apache National Wildlife Refuge in New Mexico.

Snow geese also winter on the Bosque refuge, and hunting of the geese is permitted. Hunters are trained to avoid shooting the cranes, but the goose hunt still drives the whoopers from the refuge. To avoid hunters, the cranes often feed in the surrounding countryside. This is where the problem occurs. Waterfowl hunting is widespread in the countryside. So is the accumulated lead shot from the guns of hunters. As the whooping cranes forage on the ground for food, they take in lead shot, just as they swallow fine pieces of gravel to serve as food grinders in their digestive systems.

An autopsy revealed that the gizzard of the young crane was full of lead. Three lead pellets were also found in the whooper's

flesh, indicating that it had been shot as well as poisoned. Even more troubling is evidence that refuge hunting might be interfering with the reproduction of the cranes. Usually, a male and female whooper will form a pair bond and mate for life. This pair bonding occurs on the wintering ground. It appears that the goose hunt might be disrupting the pair bonding. If so, then the hunt could be an indirect cause for the problems that this flock is having in reproducing.

The National Audubon Society has demanded an end to the hunting on the Bosque refuge. Since snow geese can be hunted elsewhere in the region, there seems to be little reason to continue hunting on the refuge. This organization has also called for the use of non-toxic steel shot in the near-by areas. (Adapted from "Unhealthy Refuge," Audubon, March, 1984)

Your job is to analyze this information, identify the variables, and write good research questions. Begin by making a list of the variables involved in this issue. (II-5)

Now, using one or more of these variables, write two good research questions that, when used to focus an investigation, would help supply the data to understand the issues more clearly.

1

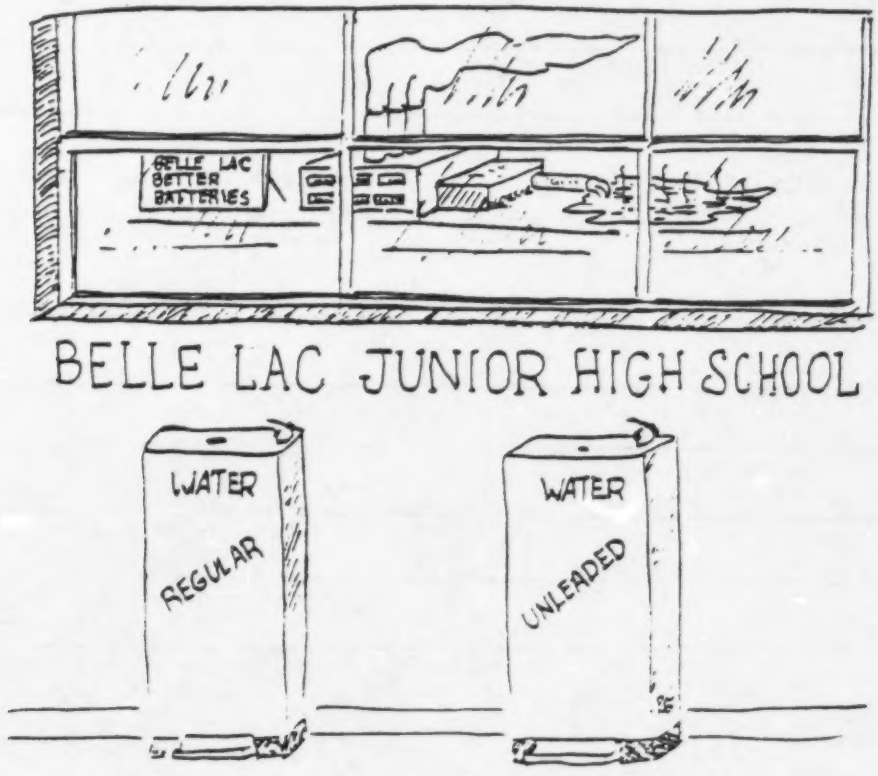
2

Let's try one other research question activity. We want you to evaluate several research questions using the criteria provided earlier in this module. These research questions might contain major flaws. Or, they might match the criteria. Your job is to decide which of the following are good research questions. Then, tell why you think the question is or is not a good one! (II-6)

1. Is refuge hunting a problem?
   Evaluation:

2. Is refuge hunting affecting whooping cranes?
   Evaluation:

3. To what extent does snow goose refuge hunting affect whooping crane pair bonding on the Bosque Del Apache Refuge?
   Evaluation:



Questionnaires

A questionnaire is a special kind of survey. It can be used to collect information that can only be obtained in this manner. A definition can be found below:

> **Questionnaire**: A carefully written set of questions about a particular subject that is given to a carefully selected sample of human beings.

It is critical to note that **questionnaires collect only hard, cold data**, i.e., facts. They do not collect opinions people have about something. Consider the examples below.

1. Number of children per family unit in a particular neighborhood or community.
2. Number of gasoline powered devices owned per family in a neighborhood or community.
3. Types of heating systems found in a particular neighborhood or community, e.g., natural gas, bottle gas, fuel oil, electric, coal, wood.
4. Garbage disposal techniques used by renters and/or home owners.
5. Number of home owners/renters recycling metal containers.
6. Average number of pets being fed by residents in a particular neighborhood or community.

Can you think of two other topics of an environmental nature that could be studied using a questionnaire? Remember to specify the particular subject topic and identify the target population. (III-2)

1. _____
_____
2. _____
_____

A questionnaire is really a special kind of survey. It requires information that can only be supplied by human beings. Thus, each research question for a questionnaire must specify a target population (or sample of a population). Reread each of your responses to make sure both the **topic** and the **target population** are included.

Now, please examine the model questionnaire and the data summary sheet on the next page.

Model Questionnaire

Glass and Metal Waste Questionnaire

This questionnaire is designed to yield usable data concerning the habits people have developed relative to their use and disposal of glass and metal containers. It should be used with a member of a household, preferably the person responsible for household management. If this questionnaire is used, the size of the sample gathered should be fairly large in order to make the data meaningful, i.e., over 50 responses. Similarly, it is suggested that data be collected and categorized (tabulated) according to particular parts of the community, i. e., high income, middle income, and low income neighborhoods.

Hello, my name is_____ I am a student at _____ school. One of my classes is doing research in environmental problems and I would like to ask you a few questions about your use of glass and metal containers. May I ask you a few questions?

Person Responding: ☐ Male ☐ Female

_____

Street City State Zip Code

1. How many people live in this household? ..... _____
2. Do you purchase any part of your groceries (other than beverages like pop, fruit juice, or beer) in metal containers? ..... Yes ___ No ___
3. Do you purchase any of your beverages in metal containers? ..... Yes ___ No ___
4 Do you purchase any beverages in glass containers? ..... Yes ___ No ___
5. Of those beverages purchased in glass containers, what percent of the beverages are in returnable glass containers? ..... _____%
6. Regarding metal cans, what percent of them do you take to a local recycling or collection center? ..... _____%
7. Regarding throw-away glass containers, what percent of them do you take to a local recycling or collection center? ..... _____%
8. Have you (or any member of your family) ever asked your grocer to stock beverages only in reusable glass containers? ..... Yes ___ No ___

Thank you very much for your help!

Glass and Metal Questionnaire Data Summary Sheet

ITEM	Population or Neighborhood A.		Population or Neighborhood B.		Population or Neighborhood C.	
No. of Males Responding						
No. of Females Responding						
Average No. of People per household						
Groceries (Not Beverages) Purchase in Metal Cans	Yes	No	Yes	No	Yes	No
Beverages purchased in Metal Containers						
Beverages Purchased in Glass Containers						
% of glass resuable =						
% of glass throw-away =						
% of cans throw away =						
% of cans recycled =						
% of throw-away glass thrown away =						
% of throw-away glass recycled =						
Has any member of the family requested a grocer to stock only resuable containers	Yes	No	Yes	No	Yes	No

What Are Some of the Basics of Sampling?

You will recall that, early in this module, we spoke of "sampling" a population in order to collect data. What is a "**population**" and a "**sample**"? How does one go about sampling a population? Is it important to be careful? Are my data better if careful sampling techniques are used?

When using questionnaires and opinionnaires a researcher has to contact people. These people usually represent a population of human beings who are somehow associated with what you are investigating. They could be residents of a particular neighborhood, or a county, or a state. They could also be members of certain organizations or racial groups or even certain age groups. The **population is all of the people in the group** you are interested in. Now, if the population is small enough, you can go to all of the people in that population. However, this is often not the case. This means that you will have to somehow select a smaller part of that population. This **smaller part becomes a sample.**

How you select your sample is very important. Why is that the case? In order to get answers which represent what all kinds of people in a population are thinking, you need to contact all those different kinds of people. In that way, your sample will represent the views of the larger population. This becomes what we call a **representative sample.**

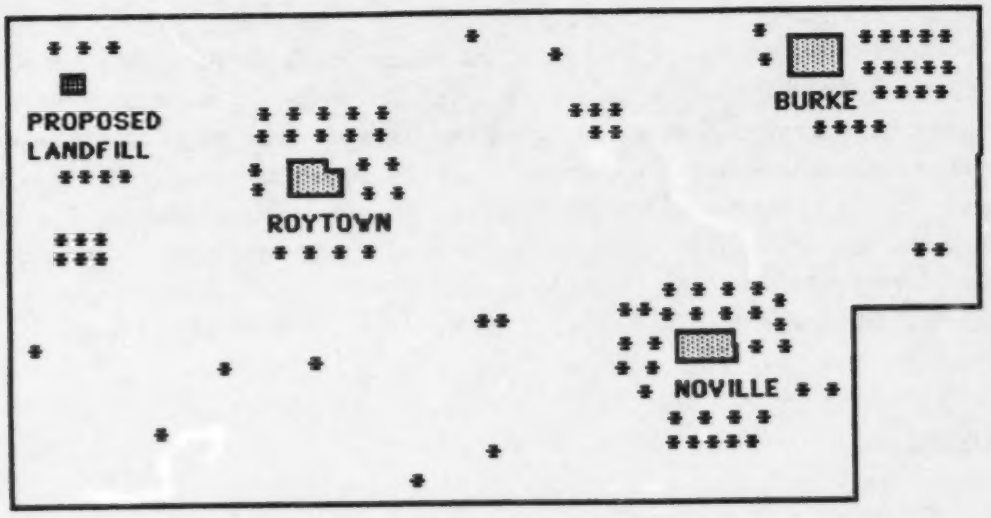
One question that is often asked relates to how many people must be included in a sample. This is a tough question to answer. Typically, if you want to get scientifically accurate information from a relatively small number of people, you should try for at least 70 people in your sample. If the number of people in your population is very large, you may want to collect data from more than 70!

Often times you just don't have the money or time to get 70 responses. If this is the case, you can obtain fewer sample members but you must somehow try to get enough responses so that all views are represented.

Here an example would help. Suppose you wanted to know what the adults in your county thought about a new landfill being created in one part of the county. Would you contact only people living close to the proposed land-fill? Or, would you contact only people in your own community (who are not close to the proposed landfill)? If you really wanted opinions of all concerned, you would have to contact people in both areas (and others as well).

Now, how do you go about sampling a population? Most experts will tell you that your sample should be random. **A random sample is one in which all viewpoints have an equal chance of being represented.** Thus, there is no bias or research prejudice in the sample. This may sound like a difficult thing to accomplish, but there are some very simple ways to get a random sample. For example, on the next page you will see a map of Mill County and the households in that county. Let's suppose that the officials in Mill County wanted to put a new landfill (sometimes called a waste disposal dump) in the northwest corner of the county. Let's also suppose that you are interested in collecting data on residents' opinions about the location of the proposed landfill. How might you go about doing

THE SAMPLING OF MILL COUNTY HOUSEHOLDS



MILL COUNTY

METHODS FOR SAMPLING MILL COUNTY HOUSEHOLDS

METHOD 1: LIST ALL HOUSEHOLDS . . . NUMBER THEM FROM 1 TO 100 . . . PUT THESE NUMBERS ON SEPARATE SLIPS OF PAPER . . . PLACE THE SLIPS IN A CONTAINER . . . DRAW 50 SLIPS FROM THE CONTAINER. THIS IS YOUR SAMPLE AND IT IS RANDOM.

METHOD 2: LIST THE HOUSEHOLDS IN BURKE . . . NUMBER THEM . . . PUT THESE NUMBERS ON SEPARATE SLIPS OF PAPER . . . PLACE THE SLIPS IN A CONTAINER . . . DRAW ONE-HALF OF THE SLIPS FROM THE CONTAINER. THIS GIVES YOU A RANDOM SAMPLE OF THE BURKE HOUSEHOLDS.

NEXT, DO THE SAME THING FOR THE HOUSEHOLDS IN ROYTOWN AND IN NOVILLE. THIS WILL GIVE YOU RANDOM SAMPLES OF THE ROYTOWN AND NOVILLE HOUSEHOLDS.

FINALLY, DO THE SAME THING FOR THE RURAL HOUSEHOLDS IN THE COUNTY. AGAIN, YOU HAVE A RANDOM SAMPLE OF RURAL HOUSEHOLDS. YOU NOW HAVE A TOTAL OF 50 IN YOUR SAMPLE.

SAMPLING RESULTS: METHOD 1: FIFTY (50) HOUSEHOLDS RANDOMLY SELECTED FROM THE ENTIRE COUNTY.

METHOD 2: TEN HOUSEHOLDS RANDOMLY SELECTED FROM BURKE, FIFTEEN HOUSEHOLDS RANDOMLY SELECTED FROM NOVILLE, TEN HOUSEHOLDS RANDOMLY SELECTED FROM ROYTOWN, AND FIFTEEN HOUSEHOLDS RANDOMLY SELECTED FROM THE RURAL AREAS.

this? The information about Mill County gives you two suggestions for randomly sampling 50% of the Mill County households.

Samples of Convenience

Sometimes researchers cannot get a random sample of a population or are unwilling to expend the time and energy to get one. In these cases, the person may choose to use samples of convenience. **A sample of convenience is made up of people that the researcher can easily contact.** For example, in the Mill County opinionnaire, if the researcher lived in Noville, he/she might choose to sample only the households in Noville. The problem with samples of convenience is that they often only reflect the viewpoints of some members of the larger population. In this example, the folks in Noville would probably have far different opinions than those living close to the proposed landfill site. Can you see what kind of problems this poses for the researcher?

Interviews

Sometimes a researcher will choose to interview a limited number of people who are closely associated with an environmental issue. In this case there are a couple of things that are quite important. First of all, the interview must be a thorough one, i.e., it must get all of the information which is important to the study. Secondly, the researcher must attempt to interview those who are really knowledgeable about the issue.

When using an interview technique, the researcher is usually trying to obtain information which is a bit different from the opinionnaire information represented by the Mill County example. In the Mill County landfill issue, a researcher might use an interview process to obtain specific facts about the proposed landfill from experts. He/she might go to sanitary engineers, waste disposal people, county officials, EPA officials, and even scientists at the state Geological Survey to get very specific data from important players in the issue. Here, the researcher is attempting to interpret the issue in a far different way than with an opinionnaire. This is an entirely different kind of research study, but it still deals with the same issue - that of the proposed landfill in Mill County. The methods you might choose to use in your own research studies will, then, depend upon the kind of research questions you are trying to answer. And, your sampling techniques will also be determined by your study.

Making a Survey, Questionnaire, or Opinionnaire:

A Planning Sequence

1. What environmental issue or condition has the class chosen to investigate?

2. What are the research questions related to this issue which you want to have answere?

3. Exactly what information (data) will be collected by this instrument?

4. Is this to be a . . . ___survey . . . ___questionnaire . . . ___opinionnaire?

5. In what geographic area will the data collection take place?

6. If this is to be an opinionnaire, what are the exact beliefs and/or opinions being investigated? _____

7. If this is to be a questionnaire or opinionnaire . . .

A. What is the exact population from which the data are to be collected?

_____

_____

_____

B. How large do you think the sample will need to be to represent the entire population? _____ Explain:

_____

_____

_____

C. How will you go about selecting your sample? _____

_____

_____

_____

_____

_____

_____

D. Which data collection technique will you use (e.g., telephone survey, mail survey, etc.)? _____

_____

8. What are the exact procedures necessary to collect data with this survey? That is, who will collect the data? How will it be recorded? During what time periods will it be collected?

_____

_____

_____

_____

_____

9. How can all the collected data be recorded and organized in a Data Summary Sheet? (Sample Summary Sheets were presented earlier in this module. You may need to design one for your survey.)

_____

_____

_____

Your Assignment: An Issue Investigation

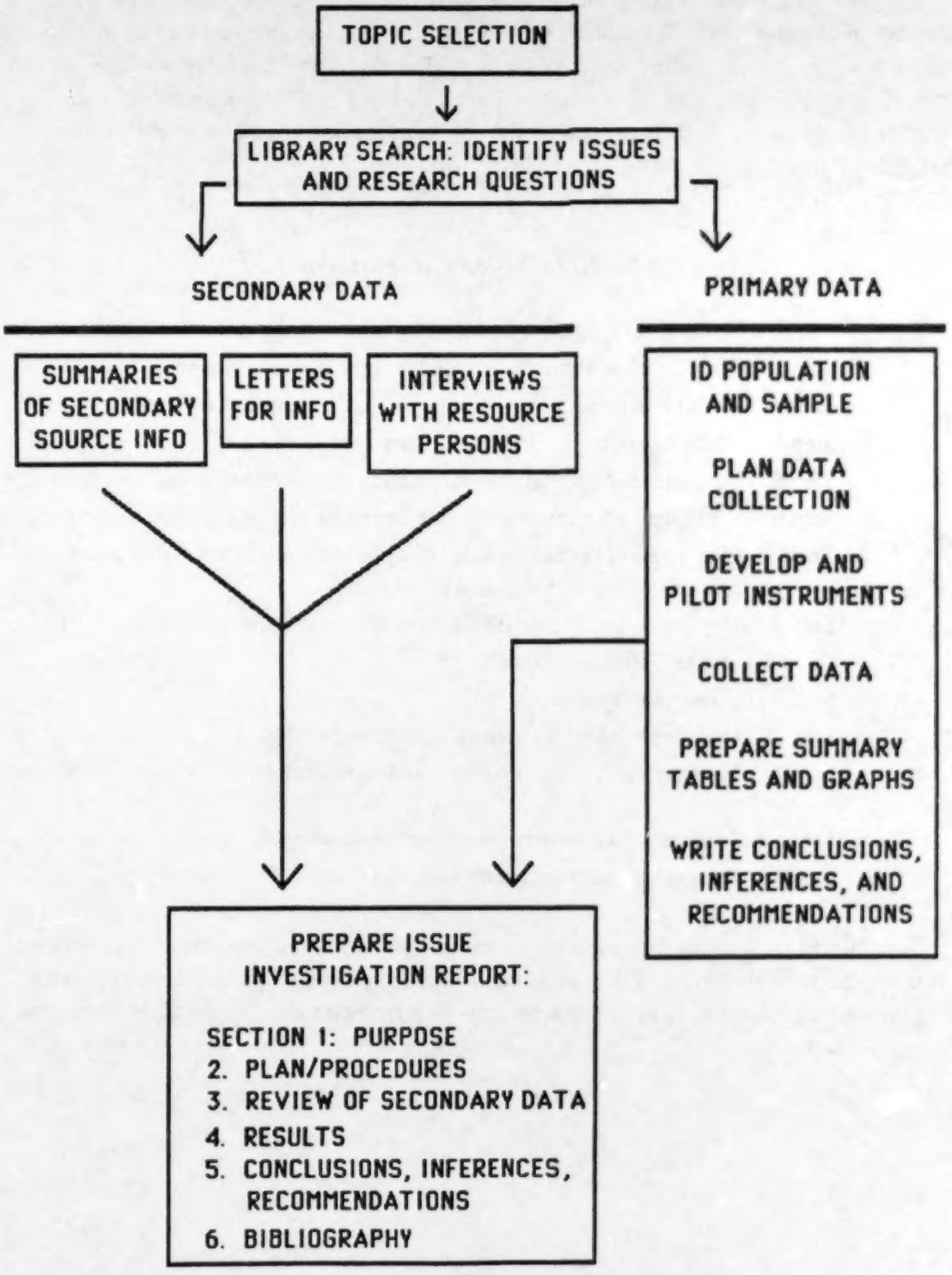
Your assignment is to conduct an issue investigation. This is a project made up of a number of complex tasks. The authors believe that your teacher can make the best decisions about how you should conduct your investigation. The discussion that follows **suggests** a model for investigating issues which has been used by many students. Remember, your teacher has the final say. Typically, the following steps are taken in many issue investigation projects:

A Model for an Issue Investigation

Step 1. Select an overall topic in which you are interested.
Step 2. Conduct your library search on the topic of interest to you.
Step 3. Identify an important environmental issue related to this topic.
Step 4. Write research questions about the issue.
Step 5. Summarize the secondary information you have collected.
Step 6. Write letters for information and interview resource people (as needed).
Step 7. Plan a data collection strategy designed to collect data which could answer the research questions.
Step 8. Develop, pilot, and revise a survey instrument (for investigations using primary sources of data).
Step 9. Collect survey data.
Step 10. Organize the data into tables, charts, and graphs.
Step 11. Interpret the findings making conclusions, inferences, and recommendations.
Step 12. Produce a final written issue investigation report.
Step 13. Present your investigation to the class.

The diagram on the following page presents these steps and provides a visual way for you to understand the nature of the task at hand. But remember, the final decision concerning the investigation rests with your teacher. So the steps you follow might differ from those presented here.

SUGGESTED ISSUE INVESTIGATION: A FLOWCHART



Decisions must be made about your issue investigation. Your teacher will communicate this information to you. Please record the exact criteria specified by your teacher for each of the headings below. (V-1)

1. **How will you organize to investigate an issue** - individually, in pairs, in small groups, etc.?

_____

2. **What kind of data should be collected** - primary, secondary (print material, interviews, letters for information), or some combination of the above? Further, how many of each kind should be used?

_____

3. **What are the components of the final product**? Typically, the report is divided into a number of sections: (1) a **purpose** section which contains the research questions and explains the importance of the issue investigated, (2) a **plan** section which details the data collection including population, sampling method, and instrumentation, etc. (3) a **literature** section which reviews information collected via letters, interviews, and secondary sources, (4) a **results** section which contains graphs, data tables, and an issue analysis (an analysis of positions, beliefs, and values), (5) a **findings** section including conclusions, inferences, and recommendations, and (6) a **bibliography.** A issue action plan might be added after you have completed Module 6.

List any additional criteria supplied by your teacher for your written issue investigation report.

_____

_____

_____

_____

_____

4. **What is the due date** for the final product? Are there due dates for various sections of the report? If so, what are they?

_____

5. **In what style should the final report be produced** . . . typewritten or by hand? What about margins? Title page? Titles for sections and subsections? Bibliography form? Etc. Etc.

_____

_____

_____

6. **Are there any other special directions and procedures** for seeking teacher help, using the library, obtaining school stationary, using the phone, copying, etc.?

_____

_____

_____

_____

You now know what your teacher expects of you. Yes, it is a big job! But many other students achieved great results doing the same task. It is now time to start making real decisions concerning your issue investigation.

Hopefully, you have a good plan for collecting quality data Still, some students have trouble meeting deadlines for big projects. One way to help use time wisely is to divide the investigation project into smaller sections. That is the purpose of the checklist that follows. Your teacher might or might not decide to use it with you. Regardless, a checklist of investigation tasks is certainly a helpful way of helping fit your investigation into a workable timetable.

You and Action: Important Ideas

This module is designed to help you learn about and develop skills for taking environmental action. The writers know of students who have

recycled aluminum on a school -wide basis,

published environmental issue reports in the regional newspaper,

persuaded city officials to start a recycling center, and

formed a five school coalition designed to lobby state legislators to vote for specific environmental legislation.

These are examples of actual actions taken by groups of young people. But there are many actions you can take as an individual which will contribute to the quality of the environment. The authors believe it is important for you to learn about environmental actions now, so that you can begin to make a difference immediately, as well as to be better prepared to make environmental decisions in the future.

The following are some principles of environmental action that we would like you to consider.

1. You have the right to be heard and to act on environmental issues, and

2. You have the responsibility to exercise that right and to be knowledgeable and skilled in such actions.

3. Some actions are mandated by law (e.g., laws against littering), but most involve your own choice.

4. You have the ability to investigate environmental issues and to obtain enough information on which to base a plan of action.

5. Most of the actions you take in your life have some environmental consequence. You have the responsibility to consider whether an action will be positive or negative over the long run.

6. You have the ability to become skilled in at least some of the methods of environmental action.

The Methods of Action

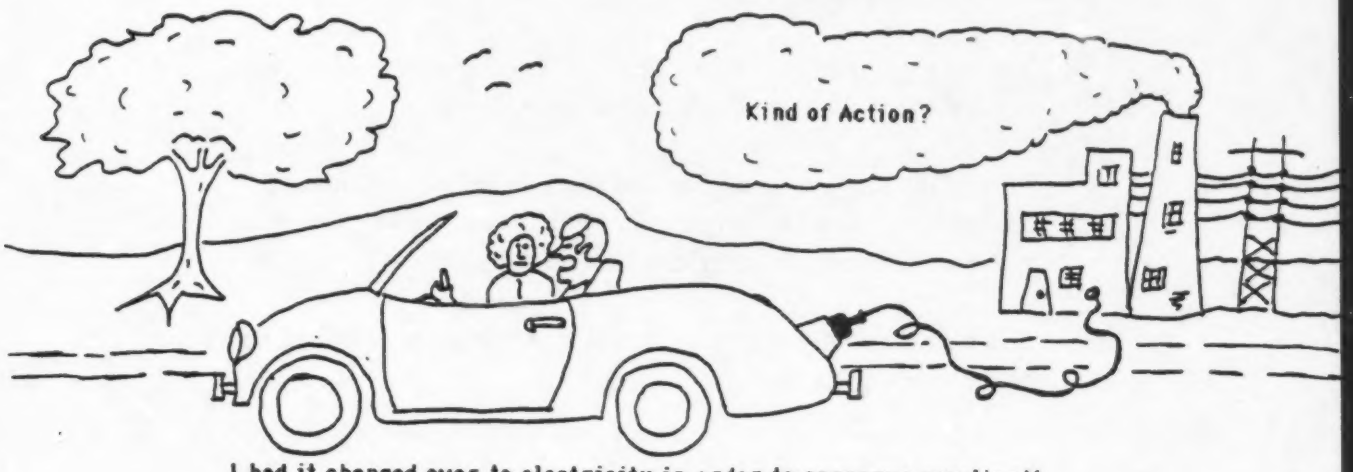
If you agree with the ideas just listed, you will want to know something about the **methods** of environmental action. If we analyze all of the available strategies for action, we find that many of them can be grouped under four headings. These follow:

Action Method I - Persuasion: Persuasion is used when someone or a group of people is trying to **convince others** that a certain source of action is correct. How many times in your life have you tried to convince someone that your position is the right position? This takes persuasion to be effective, particularly if that person or group doesn't agree with you at first.

Action Method II - Consumerism: Consumerism relies on the power of the pocketbook or billfold. It involves **buying something** that agrees with one's philosophy or **not buying something** that represents an action or an idea one disagrees with. Consumerism is particularly effective if a group of people get together to take action. Even so, some individuals act alone in this dimension. Examples of consumerism? Refusing to buy soft drinks unless they are in returnable bottles. Refusing to purchase articles made in a foreign country which has a negative environmental policy. Buying products made by companies who try to reduce environmental pollution.

Action Method III - Political Action: Political action refers to any mode of action that brings **pressure on political or governmental agencies and/or individuals** in order to persuade them to take positive environmental action. In democratic nations, political action usually means supporting candidates who have positions similar to your own. It means pressuring people in office with letters, telegrams, and phone calls. It means casting a vote for or against a particular issue . . . and more.

Action Method IV - Ecomanagement: Ecomanagement is simply a word used to describe any **physical action taken with respect to the environment.** It can be illustrated by examples ranging from picking up someone else's litter to helping a private agency buy and preserve an ecologically-important forest. Ecomanagement, hopefully, results in either maintaining a good environment or improving a weakened environment.



I had it changed over to electricity in order to conserve gasoline!!

ISSUE ACTION PLAN
(VI-8)

Part 1. The Issue

1. Restate the problem and/or issue investigated (from Module V):

2. Write a **summary statement** of the issue, including the alternative positions which can be observed, i.e., the different beliefs and values associated with it.

3. Write a summary statement which **evaluates** the status of the issue, e.g., its current status, its seriousness, public attitudes toward it, its importance compared with other issues, etc.

4. Write a statement which states your **conclusions** concerning the issue. This could include your own position regarding this issue.

Part II. Appropriate Actions

5. What citizenship actions are you, **as an individual**, considering for effectively and responsibly solving this issue?

6. What citizenship actions are you, **acting with a group**, considering for effectively and responsibly solving this issue?

7. Which action or actions do you consider to be the **most powerful** one(s) available for helping to resolve this issue? Why?

8. Prepare a brief **step-by-step outline** of the steps you plan to follow to achieve the resolution of this issue. Beside each step note the time, resources, and other information critical to that step.

Part III. Applying Action Analysis Criteria

Consider the action(s) stated above in answering the following questions:

A. To what extent is there sufficient evidence to warrant action on this issue?

B. Are there other alternative actions available for use? Yes ___; No ___. If so, what are they?

C. Is this action the most effective one available? Yes ___; No ___. Why?

D. What are the legal consequences of this action?

E. What are the social consequences of this action?

F. What are the economic consequences of this action?

G. To what extent do my personal values support this decision?

H. What are the beliefs and values of others who are involved in this issue?

I. Do I understand the procedures necessary to take this action? Yes ___; No ___.

J. Do I have the skills needed to take this action? Yes ___; No ___.

K. Do I have the courage to take this action? Yes ___; No ___.

L. Do I have the time needed to complete this action? Yes ___; No ___.

M. Do I have all of the other resources needed to make this action effective? Yes ___; No ___.

N. What are the ecological consequences of this action?

Part IV. Your Decision - The Action Recommendation

Taking into consideration the analyses you have just completed, state your final recommendations for action?

GLOSSARY OF TERMS

Abiotic: nonliving; an abiotic variable in an ecosystem would be exemplified by such things as light, rain, moisture, heat, bedrock, and topography.

Access: to get; to secure, acquire.

Acid Rain: Rainfall (or fog) which is more acidic than normal, often caused by an infusion of sulfur and nitrogen compounds from vehicular exhausts and coal burning power plants.

Adaptation: a particular attribute which contributes to an organism's survival in a community, e.g., protective coloration.

Ad Hoc: special or temporary, as in an ad hoc committee.

Advocacy: pleading a cause of another person; the act of advocating; supporting.

Affective: relating to feeling, emotion, or desire.

Agrarian: pertaining to farming, agriculture. An agrarian society is one in which the economy and culture are tied mainly to agricultural (rather than industrial) enterprises.

Ancillary: subordinate; of related but not of primary importance.

Aquifer: a place where water is found within the earth's crust (this water known as ground water).

Astute: keen in judgement.

Autonomous: independent, without outside control, self-regulating.

Axiology: a study of the nature, types, and criteria of values and of value judgements.

Behavioral (in an educational context): pertaining to actions of an individual, behaviors; often referred to in education as an action/behavior which is observable, overt.

Belief: that which a person holds to be true.

Biodegradable: any material that can be broken down in the environment by decomposers, e.g., paper products, human sewage, vegetable matter.

Biogeochemical cycles: those chemical cycles that are critical to the maintenance of ecosystems, e.g., nitrogen cycle, calcium cycle.

Biosphere: that relatively thin "shell" surrounding the earth that supports life.

Carnivore: an organism that kills and eats animals, e.g., lion, hawk, owl, snake.

Citizenship action skills: skills related to the actions and behaviors which citizens have at their disposal in working toward the solution of environmental issues.

Cognitive: related to the mental processes by which knowledge is acquired; cognitive may relate to either an individual's knowledge or an individual's ability to process knowledge.

Community: in an ecological sense, an interacting and interdependent set of plants and animals, e.g., a prairie community, a pond community.

Composting: the process of speeding up the decomposition of organic debris such as leaves and vegetable wastes in order to produce material that can be used as humus or fertilizer.

Conceptual: relating to mental images held by individuals and associated with events and objects; ideas.

Consumerism: an economic threat by an individual or a group aimed at some form of behavior modification in business or industry, e.g., boycotting, discriminating and conservative use of goods and services.

Contingency: an adjunct or accessory; a contingency plan would be a plan that could be substituted for the primary one.

Criteria: standards; rules by which something is judged or evaluated.

Critical thinking skills: those mental processes which enable a human being to process information in logical ways; cognitive problem solving skills; science and social studies process skills are critical thinking skills.

Demographic: relating to populations and the study of them, e.g., births, deaths, marriages, health, etc.

Desertification: the conversion of a productive ecosystem to desert through overgrazing, prolonged drought, or climatic change; often associated with man's activities.

Designee: an appointee; an individual designated for some task.

Didactic approach: an educational (instructional) methodology focusing mainly on a lecture delivery format, deductive in nature; the teacher as the source of knowledge.

Dynamic equilibrium: a tendency toward homeostasis; stability over time with periodic fluctuations.

Ecology: the scientific study of the interrelationships that exist between organisms and between organisms and their physical environment.

Ecomanagement: any physical action taken by an individual or a group aimed directly at maintaining or improving the existing ecosystem(s), e.g., reforestation, landscaping, installing bird boxes.

Ecosystem: an aggregate of plants and animals which are interdependent plus the abiotic variables with which they interact; typically thought of as self-contained in the sense that many of the essentials for life can be cycled and recycled within that system.

Effluent: wastewater from a sewage plant or industry.
e.g.: symbol for "for example".

Egocentric thought: A tendency on the part of individuals to assume that all others see things as they see them.

Emigration: the movement of members of a population out of one locality into another; usually a permanent move.

Empathy: a feeling for; sympathetic identification with something, such as empathy for an endangered species.

Empirical: based on observation; founded on direct experience or experimentation; scientific.

Empiricism: the mode of thought which is typically scientific in nature, a philosophy focusing on the reality of observation and experience as the basis of truth; scientific method.

"Empowerment": as used in this document, a personal feeling of being in control of a situation, e.g., the individual becomes convinced that he/she is able to effect change with regard to a particular environmental issue.

Energy pyramid: the tendency for usable energy to be lost as it moves through a food chain; often a diagrammatic representation of available energy at various stages in a food chain.

Energy transfer: in ecology, the movement of energy from one life form to another in a food chain.

Entropy: a measure of the degree of disorder brought about by an increasing complexity within a dynamic system; a thermodynamic measure of energy unavailable for useful work in a system undergoing change.

Environmental action skills: see "Citizenship action skills".

Environmental education: that aspect of education that develops individuals who are environmentally knowledgeable and, above all, skilled and dedicated to working, individually and collectively, toward achieving and or maintaining a dynamic equilibrium between the quality of life and the quality of the environment.

Environmental Impact Assessment: An evaluation of the extent to which certain activities will negatively impact/influence the environment.

Environmental issue: a problem with obvious environmental overtones surrounding which one can observe differing human beliefs and values.

Environmental literacy: that state in which an individual is environmentally knowledgeable and, above all, skilled and dedicated for working, individually and collectively, toward achieving and/or maintaining a dynamic equilibrium between quality of life and quality of the environment. (Paraphrased from Harvey, 1977)

Environmental sensitivity: a set of affective characteristics which result in an individual viewing the environment from an empathetic perspective.

Erosion: the processes by which the materials of the earth's crust are transported from one location to another by forces such as gravity, wind, water, and glacial ice.

Espouse: to take up a cause; to take up as a supporter of a cause.

Facilitator: a person who makes something easy or less difficult.

Feasible: possible; if something can be done it is feasible.

Food chain: a linear pattern describing the flow of energy through an ecosystem; typically beginning with a food producing plant being eaten or partially eaten by a herbivore which is, in turn, consumed by a carnivore, etc.

Food web: a set of interrelated food chains within a given ecosystem.

Formal educators: those educators who typically teach within the constraints of the traditional school; classroom teachers.

Herbivore: an organism that eats plant material, e.g., rabbit, mouse, ground hog, deer.

Hierarchy: an organization of things arranged one above the other according to a logical order, e.g., a hierarchy of goals.

Homeostasis: the tendency to maintain normal internal stability in an organism or an ecological system, such as a hardwood forest, by coordinated responses of the system's components, compensating for environmental changes.

Humidity: a measure of the amount of moisture in the air.

i.e.: symbol for "that is".

Immigration: the movement of a population or a portion of a population into a particular area; usually a permanent move.

Impetus: a driving force; incentive; stimulus.

Incineration: the burning of something; often refers to a method of disposing of solid wastes in an incinerator.

Infusion: an injection of one thing into another; the process of infusion; as used here, injecting traditional course content with appropriate/logical environmental content, skills, and activities.

Insolation: the amount of light energy that an area receives from the sun.

Interspecific competition: two or more species of organisms competing for the same resource in a particular ecosystem.

Intraspecific competition: two or more individuals of the same species or organism competing for the same resource in a particular ecosystem.

Irreconcilable: not reconcilable; problems which cannot be resolved are considered to be irreconcilable.

Issue investigation skills: those skills which will permit the learner to successfully research an issue, resulting in appropriate conclusions, inferences, and recommendations.

J-curve: associated with the letter "J" which depicts the growth curve of an eruptive population or organisms, e.g., man.

Learner objectives: those objectives prepared for the student to learn/accomplish; objectives which will be met through instruction, usually stated in performance (behavioral) terms.

Legal action: any legal/judiciary action taken by an individual and/or organization which is aimed at some aspect of environmental law enforcement - or, a legal restraint precedings some environmental behavior perceived as undesirable, e.g., law suits, injunctions.

Limiting factors: in ecology, those variables which tend to put limits on the development of an ecosystem or on the activities of an organism; anything present in insufficient amounts so that an organism's survival and/or reproduction is restricted.

Lithosphere: that part of the earth's crust made up of solid material, as opposed to the "hydrosphere".

"Midnight dumping" (of wastes): the discarding of wastes by individuals who do so in an illegal and secretive manner.

Monobiotic agriculture: growing only one crop in a relatively large area, e.g., a pine plantation, corn field, soybean field, rubber plantation.

Natality: refers to live births or birth rate.

Natural selection: the survival of a genetic form over time as a result of a particular adaptation favoring that organism.

Niche: an organisms' role in a community; not to be confused with where an organism lives.

Nonformal educator: the educator who provides instruction in settings beyond the traditional confines of a formal classroom, e.g., a teacher in an environmental center.

Omnivore: an organism that eats both plants and animals, e.g., grizzly bear, red fox.

Opinionnaire: a survey instrument designed to assess the opinions of a particular population of human beings on a specific topic.

"Ownership": as used in this document, a feeling of empathy or personal association with a particular issue; to feel an intense interest in a particular environmental issue with an associated desire to investigate and help remediate it.

Parameter: a limit; boundary.

Performance objective: See "learner objective".

Persuasion: an effort, verbally, to motivate human beings to take positive environmental action as a function of modified values, e.g., argumentation, debate, speech making, letter writing.

Pervasive: diffused throughout; to permeate.
Phenomena: events; happenings that may be observed. Singular: phenomenon.

"Player" (in an issue): someone involved in an issue, a person having definite beliefs (and a particular position on the issue) and certain supporting values.

Point sources (of pollution): a specific and definable point which serves as a source of pollution, e.g., smoke stack, sewage treatment plant.

Political Action: an effort aimed at persuading an electorate, a legislator (or legislature), or executive governmental agency to conform to the values held by the person or persons taking that action, e.g., lobbying, voting, supporting candidates.

Population dynamics: those interactions which can be observed taking place within a particular species population; population dynamics often refers to those variables which influence the population size of an organism over time in a given ecosystem/biome.

Portray: to make a picture of image of; to depict in words; to describe vividly.

Prerequisite: required before; necessary as a preliminary to a proposed act.

Primary source of information: a source of information which represents an original source of knowledge, e.g., information from the people actually involved in an environmental issue as opposed to information from an article written about those people.

Proponent: one who makes a proposal; an advocate.

Psychomotor: related to physical skills, as with someone with unusually fine motor skills, coordination.

Questionnaire: a survey instrument designed to gain information held on a particular topic by a certain population of human beings, e.g., college students, the general public, wildlife biologists.

Radioactivity: the property of being radioactive; the radiation given off as a consequence of radioactive decay, e.g., the radioactive decay of plutonium.

Rationale: an explanation; an underlying reason.

Recycle: to use again, in some productive manner, materials which are often considered as solid wastes by segments of a human population, e.g., aluminum, paper products, glass, plastics.

Remediate: to remedy, to restore, cure.

Role playing: to assume the role of a particular individual in an educational simulation activity, e.g., a student "plays the role" of a conservationist in a simulation designed to explore all sides of a particular environmental issue.

Scenario: the outline or synopsis, step-by-step, of a plot or an event; contains all the details of a plot or an event.

Science processes: those critical thinking skills a scientist uses to collect data or solve problems, e.g., hypothesizing, experimenting, inferring.

Scientific literacy: the state of being literate in science; an awareness of and ability to use science, its content, processes, and applications.

Secondary source of information: a source of information at least one time removed from the primary/original source, e.g., reading an article written about an issue as opposed to investigating that issue on a first-hand basis.

Simulation: something that assumes the appearance of reality without being real; the act of simulating; feigning.

Sociocentric thought: the ability to take into account that others may have a different point of view

Solicit: to seek to acquire; to plead for; to request.

Solid waste: materials thrown away and in need of disposal, not usually associated with wastes such as radioactive or toxic/chemical materials; often wastes with materials which could be recycled.

Spatial: pertaining to space.

Species population: an interacting group of organisms belonging to the same species; not to be confused with the species as a whole.

Stance: a position; someone's posture on something.

Strip mining: the removal of the surface layers of soil and rock so that important mineral deposits can be removed for use by man.

Subsidence: a sinking of the earth's surface due to some underground excavation, e.g., the removal of ground water or shaft mining.

Substrate: a foundation; a term often used in agriculture and ecology to refer to subsoil or the rock layers underlying subsoil.

Subsumes: include under; to take up; specifics are subsumed within the general, or individuals are subsumed within populations.

Succession: the progression of plant communities from one to another in a given locality; often begins with a pioneer community progressing through a series of plant communities toward a climax plant community.

Survey: a mechanism for gathering information about something, e.g., a survey of abandoned vehicles in Jackson County, Illinois, a survey of public opinions concerning the acid rain issue; to take a broad or comprehensive view of something.

Synergism: an interaction which yields a greater effect than the sum of the two effects where the interaction does not take place; combined action, such as the synergistic effect of two drugs being greater than the effect of either taken individually; in an environmental sense, often the combined action of substances in the environment.

Syntax: orderly arrangement; to put in order, a sequence.

Synthesis: a combination of parts as to form a whole; building up something from its elements; combination of thoughts into a whole; the opposite of "analysis".

Topography: the undulations of the earth's surface; the configuration or relief of a surface.

Value (i.e., a value): an established ideal; a way of acting; the perceived worth of something, e.g., the perceived worth of wildlife.

Values clarification: the process an individual goes through as he/she inspects the bases for a value perspective, e.g., the process and individual would go through as he/she seriously inspects a personally and particularly strong economic value.

Value position: the value category underlying a particular belief statement or verbalized position on an environmental issue, e.g., a person who wants to preserve a marsh because there is good duck hunting there is reflecting a recreational value position.

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